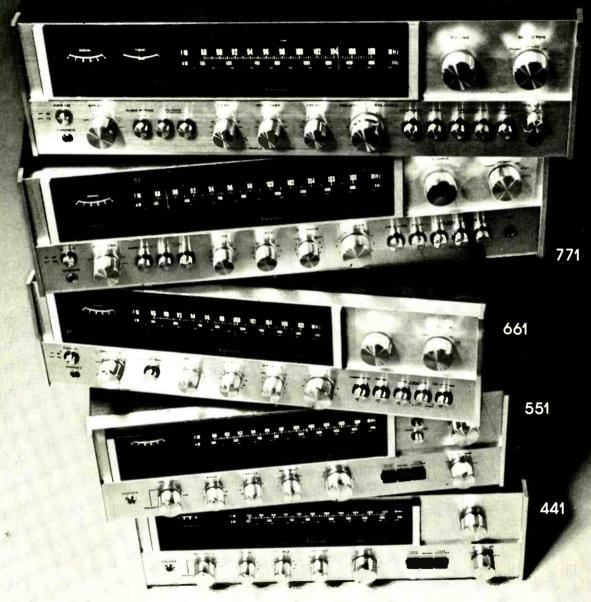


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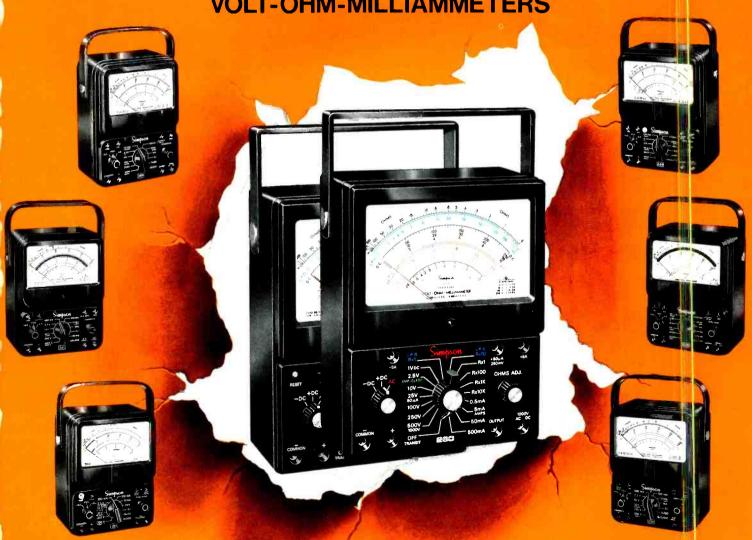
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AC Volts:

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DC Milliamperes:

0-0.5; 0-5; 0-50; 0-500

DC Amperes:

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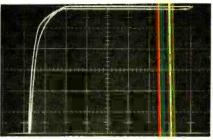
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TYPICAL WAVEFORM PRODUCED BY A CURVE TRACER shows reverse characteristics of a small-signal silicon diode. It's just one of several interesting our re-tracer applications. ... see page 58

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3

looking ahead

50-in-one

Peter Goldmark's latest gadget is a system which permits the transmission of 50 — count 'em 50 — visual and aural programs in the bandwidth of a single television channel. At press time, there had been no announcement of the system, known as RTS, but we've learned that it allows the multiplexing of 50 slow-scan "slide" programs with full audio for transmission on a television channel via microwave or broadcast. With a reduced number of programs, an FM subcarrier (SCA) could be used to send audio-visual information. Goldmark's company, Goldmark Communications Inc., is promoting the system for education and aiming it primarily at networks of community colleges. It's understood that the pilot project will be at Piedmont Central Community College in Charlotte, N.C.

For better UHF

More than 60% of Public Broadcasting stations are in the uhf band, so it's only natural for Public Broadcasting Service to be concerned about the problems - and future - of uhf. PBS President Hartford Gunn has urged educational television stations to mount a concerted campaign to help make uhf equal to vhf at both the transmitter and receiver levels, uhf, he noted, has achieved complete parity with vhf in Great Britain and other European countries, and the same could be accomplished here with proper legislation and FCC rules.

Gunn cited a special survey conducted for PBS by Hazeltine Research, which found that the addition of rf amplification and PIN diode attenuators to home receivers could effect an im-

provement comparable to doubling the transmitter power. The cost to manufacturers, he said, would be about three dollars per set, translating to nine dollars at retail. He urged public broadcasters to appeal to the FCC and Congress to mandate better receivers. At the same time, he called attention to a recent study of the PBS Engineering Committee, which recommended a minimum uhf station operating power of two megawatts and antenna height of not less than 1,000 feet above average terrain. These minimums, he said, are met by only six of 135 public TV stations surveyed.

Sony's home projector

A home version of Sony's industrial-educational projection television system is definitely scheduled marketing in the United States this fall. Like the current non-consumer version, it's expected to use a 12-inch Trinitron receiver as the projection source, but instead of the two-piece (projector and screen) approach, it's mounted in a single furniture-styled cabinet that looks like a secretary desk. The screen is in the upper portion and the TV projector and optical system are concealed in the hinged lower part when not in use. The screen is expected to measure about 30 by 40 inches, and the price will be between \$2,500 and \$3,000. The Sony unit will be the third projection color set on the consumer market. The others are the Advent Video-Beam two-piece system with a 52 by 69-in, screen and on assembled by Muntz Elman Manufacturing, which has a picture about the same size as the Sony.

Television injuries

Did you know that an esti-

mated 14,000 Americans checked into hospital emergency rooms in the year ending last June 30 with "television-related" injuries? That's the total projected by the Consumer Product Safety Commission on the basis of 710 actual cases reported through the National Electronic Injury Surveillance System. When you think of "television-related" injuries. you may conjure up visions of shocks, fires and implosions. But in the vast majority of cases reported, there was nothing wrong with the set at all. In fact, 97 percent of the injuries resulted from people bumping into television sets, dropping them on toes, and so forth. Nearly half of the victims were children under five.

In another development, the Consumer Product Safety Commission disagreed with Consumers Union on the question of safety of slide switches, commonly found on many brands of television. CU had rated one such set not acceptable on the grounds that someone pushing a coin or some other metal object into the slot could get a potentially lethal shock. The safety commission disagreed, a spokesman noting that the set in question met UL safety standards and that the commission had never received a report of injury from slide controls, which have been used in television sets for six years.

Latest on home VTR

The dream of a popular-priced home videotape recorder remains a dream. Various plans by manufacturers to introduce such an instrument have repeatedly been postponed — partly because of the unpropitious economic conditions today and partly because of extremely high costs. But this doesn't prevent the development of new home VTR systems, and we're seeing about

one new idea a month.

This month's new system represents an attempt by major Japanese manufacturers to establish a "standard," with complete interchangeability of tapes. The new system - being promoted by Matsushita (Pana-Toshiba, Hitachi, sonic). Mitsubishi and Sharp - is a variation of the standard cartridge videotape recorder used for industrial and educational purposes. The previous drawback of Japanese system had been the ability to record only one-half hour on a cartridge. The proposed new home system squeezes a full hour of playing time into the same single-reel cartridge of halfinch tape. It will be submitted this spring to the Electronic Industries Association of Japan for listing as a standard. Sony has been pushing for a different half-inch-tape system, but there have been no reports so far that any other Japanese or American manufacturers plan to adopt it. The new Sony system, originally scheduled for sale this year, no longer seems to have a definite timetable.

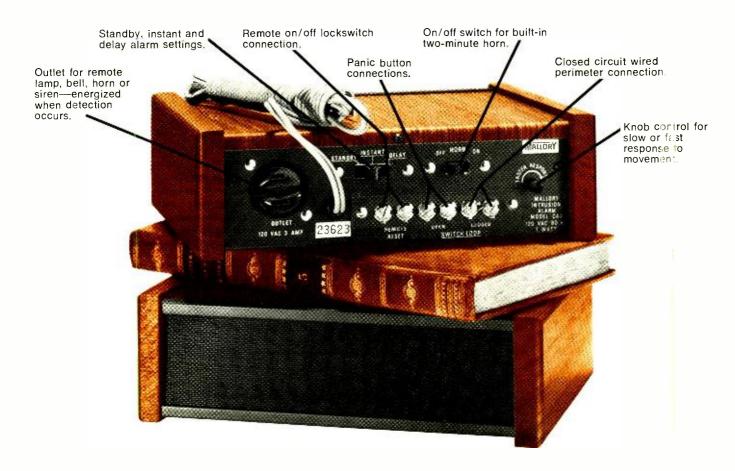
Calculator suit

Brewing for a long time, a major patent and anti-trust suit has erupted in the calculator industry. Bowmar Instruments has filed a \$240-million triple-damage action against its chip supplier Texas instruments, charging that TI went into competition with it in producing hand-held calculators using its confidential trade secrets. It also accuses TI of selling below cost to injure competitors and refusing to sell certain components to Bowmar and others. TI said the charges were "totally without merit."

by DAVID LACHENBRUCH CONTRIBUTING EDITOR

The new Mallory CA3 Intrusion Alarm.

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This area-and-perimeter device creates and transmits an ultrasonic wavelength field for detection up to a distance of 20 feet. And because of its modern design and walnut-grain finish, the CA3 is attractive and inconspicuous enough to pass as a radio or stereo tuner.

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new & timely

Computer uncomplicates scoring at national gymnastic contest

Contestants and spectators at the NCAA 32nd National Gymnastics Championships, knew the exact scores and standings of individuals, teams and schools at all times during the meet, for the first time in 32 annual contests. An IBM 370/168 computer with a remote terminal on the gymnasium floor was the reason for the breakthrough.

The competition, which included 43 universities represented by more than 180 performers, requires some 5,000 scores to be tabulated during the competitive events. In pre-computer days,



SILENCE WAS AN ADVANTAGE of the Tektronix computer display terminal that was set up on the gymnasium floor of the NCAA National Gymnastics Championships at Penn State University. The gymnasts were able to perform absolutely without distraction, and the records of their performance were transmitted across the campus to the computer at the University's Computation Center.

this called for a small army of scorekeepers who worked all night—and sometimes several days—to total the scores, calculate the final standings and make up the tabulations.

The scoring is complicated by the necessity of showing the standings of individuals, teams and universities, all separately. Since some competitors are eligible for team medals only, others for individual events only, some for an all-around medal and a few eligible for

any combination of these, a second degree of complication is introduced.

The 370/168 was programmed with APL language, a tool execellently adapted to the collection and analysis of the complex scoring. The computer could on command immediately print out the standings in any given event, the team totals at any time and the complete record of any individual's performance during the meet, showing everything he had competed in and his standing in each event.

The computer was linked by telephone line to a terminal—a Tektronix 4013 computer display terminal—on the gymnasium floor. Three other terminals—Datel 1030's, which give a hard copy printout—kept the press, the coaches and the contestants abreast of the situation at all times.

DR. ADLER CITED BY CHICAGO IEEE



DR. ROBERT ADLER, FAMED INVENTOR and Zenith's vice president and director of research, was given the Outstanding Technical Paper award by the Chicago section of the IEEE, for a paper entitled "An Optical Video Disc Player for NTSC receivers."

Dr. Adler is best known to the television world for his invention of the ultrasonic remote control and the gated-beam tube for sound and color demodulation, as well as a widely used synchronizing circuit that improves color reception and a system of projection television that uses a laser beam modulated by ultrasonic diffreaction.

Among his other inventions are a highfrequency magnetostrictive oscillator and electro-mechanical filter and the low-noise beam-type amplifier known as the Adler tube.

New Marine backpack transceiver will have 280,000 radio channels

A far cry from the famous "walkie-talkie" of 30 years ago-which had a

useful range of only a few miles ("reliable" or minimum range, only 3 miles)



"MANPACK" COMBAT RADIO HAS 280,000 channels to select from. Using groundwave transmission for distances of a few thousand yards and skywave transmission for possible ranges in the thousands of miles, it will normally be used for distances ranging from local up to a few hundred miles.

and operated on a single frequency—the new "Manpack" radio offers the operator a choice of some 280,000 high-frequency channels, and can communicate over thousands of miles. (Normal working range would be from 50 to about 300 miles, plus short-range local traffic)

The new AN/PRC-104, being developed by the Hughes Aircraft Co. for the Marine Corps, is only 12½ inches wide, 11½ high and 2% thick. Its weight is 12½ pounds including battery, about one-third that of the famous SCR-300 walkie-talkie of 1944. It is so nearly automatic as to be called a "hands-off" transceiver. "The radioman simply goes into the transmit-receive mode, selects his frequency and hits the press-to-talk switch. Then the antenna is tuned, the set aligned, and the transmitter comes up immediately to full power," explains a Hughes communications manager.

The new Manpack is a single-sideband transceiver, producing 20 watts peak output power but using less than 5 watts average power. The battery operates 16 hours without recharging.

Production will be in two stages, a first step in which 37 radios and 10 vehicular mounts will be delivered to the Marine Corps for testing, then 5,000 sets to be delivered after the results of the Marine Corps' testing are incorporated into the equipment design and manufacture. (continued on page 12)

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UNIVERSAL REPLACEMENT TUNER \$12.95 (Cana :a \$15.95)

- This price buys you a complete new tuner built specifically by Sarkes Tarzian Inc. for this purpose.
- All shafts have a maximum length of 10½" which can be cut to 1½".
- Specify heater type parallel and series 450 mA
 or 600 mA

CUSTOMIZE

- Customized tuners are available at a cost of only \$15.95. With trade-in \$13.95. (Canada \$17.95 and \$75.15)
- Send in your original tuner for comparison purposes to Franchises listed below.



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Almost half of the successful TV servicemen have home study training and with them, it's NRI 2 to 1.

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As a part of NRI's Master Course in TV/Audio servicing, you build a big-screen solid state color TV with every

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instruments are a cut above the average, including a $3\frac{1}{2}$ digit precision digital multimeter, triggered sweep 5" oscilloscope, and integrated circuit TV pattern generator. They're top professional quality, designed to give you years of reliable service. You can pay hundreds of dollars more for a similar course and not get a nickel's worth extra in training and equipment.

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Circle 5 on reader service card

new & timely (continued from page 6)

Dr. Lewis M. Hull honored by Radio Club of America

The Armstrong Medal for outstanding contributions to the radio art was awarded to Dr. Lewis Hull by the Radio Club of America, world's oldest radio club, at its 65th anniversary meeting and banquet November 15.

Dr. Hull pioneered in radio reception and in aircraft radio. Numerous firsts, such as single control for receivers. automatic volume control and the auto-



Dr. Lewis Hull

matic noise supressor, were developed under his direction. He was a leader in aircraft radio design and production, and in the early part of World War II practically every US combat plane was equipped with Dr. Hull's radios.

The Sarnoff Citation for significant contributions in electronic communication was given to Jack R. Poppele, former vice president of WOR and the Mutual Broadcasting System and later director of the Voice of America, Designer and builder of WOR, he and Dr. de Forest threw the switch that put it on the air in 1922. He then served as its Chief Engineer for 30 years. A Fellow and director of the Radio Club, he is also president of the Veteran Wireless Operators Association and of the de Forest Pioneers.

Dr. George Bailey, for years leader of the world's amateurs as president of the American Radio Relay League and the International Amateur Radio Union and later Executive Secretary of the IEEE, was made an Honorary Member of the Club. He is one of the seven members to hold that distinction.

The meeting was addressed by William M. Nicol, Director of Telecomnecessity of improved public safety munications of the British Home Office, London, England, who discussed the communication both nationally and internationally.

Besides the honors to Hull, Poppele and Bailey, 20 members of the Club were raised to the rank of Fellow. Among them were Norman Chalfin, author of a number of articles in this magazine, and Gerald F. J. Tyne, the historian of the vacuum tube, who described the making of early Audions for the readers of Radio-Electronics.

Ladies' electronic wrist watch tells time in two sentences

A new digital watch module, now in limited production at Hughes Aircraft Company's microelectronic products division, is called the first designed for ladies-size watches.

The solution of the size problem is unique, Instead of a four-digit display reading out the hour and minute, the new watch has a two-digit display, showing first the hour, then a second later, the minute.

As in earlier Hughes watch modules, the new model has a 768-kHz crystal oscillator, considered more accurate than the 32-kHz type used in most electronic watches. The integrated circuitry consists of CMOS (complementary metal oxide semiconductor) chips, and contains the equivalent of more than 1,500 transistors.

No Hughes watches will appear on the market. Hughes sells the modules to watch manufacturers, and the two-digit ladies' watches may soon be expected to appear under several of the better well-known brands.



TWO "POINTS IN TIME" ARE SHOWN in this interesting photo. The small wrist watch first shows the hour (above). The lower part of the picture, presumably photographed about a second later, indicates the minute. R-E

GENERAL ELECTRIC INTRODUCES THE 4-MINUTE HALF HOUR

GE's Latest In-Line Deflection and Convergence System hailed by TV technicians.

General Electric's latest in-line system makes it possible to converge a color set in three to four minutes, as opposed to the standard time of ten to 30 minutes. It was enthusiastically received at state conventions, where TV technicians and shop owners called it an important advancement in serviceability.



"Saves 30 minutes in convergence, compared to standard Delta convergence."
Dick Regner, RRR TV, Pearland, Texas



"G.E.'s...convergence system is great. They should have called it the 'time saver'." Sidney J. Sabel, Sabel's T.V. Service, Houston. Texas

"Easy to converge, little return to readjust controls."
Charles Miller, Miller's TV Service, Virginia Beach, Va.

Time saving. Very flexible. More control." G. F. Hill, Bay Area TV & Communication. Seabrook, Texas

Beats the heck out of other systems!"
E. B. Swanson, E. B. Swanson Company, Crosby, Texas

Another feature that met with enthusiastic approval was the fact that a technician requires no additional training to converge the set for a sharp, clear picture. A simple control location guide is included inside the set.

... simple convergence is extremely important. Will make training to technicians very easy."

Gary Gray, Master TV & Appliance Co., Roanoke, Va.

ʻIt's a serviceman's dream. Easy. Simple The way to go!'

Ira Evans, Evans TV, Freeport, Texas

"Fantastic! Great! I wish everyone weald go to it.

David Christian, Whitehill Elec., Kannapolis, N.C.

"Very simple. Easy to do without previous instructions.

Earl Asher, Asher TV, Denton, Texas



"Greatest improvement in convergence in 15 years. Bill Nichols, Radio & TV Service, Irc Petersburg, Va.

This latest in-line deflection and convergence system is in all GE 13" and 17" (diagonal) YA solid state chassis sets.

We're making it our business to make your business easier.

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TV Receiver Products Dept., Portsmouth, Va.



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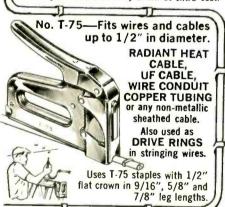
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Circle 7 on reader service card

equipment report

Hickok model 246 deluxe color bar generator



Circle 113 on reader service card

TEST EQUIPMENT IS GETTING MORE COMpact all the time. Unlike the circus, that says "bigger and better." they get "smaller and better." The use of IC's has been helpful in two ways, especially in the area of signal generators. The newest item in this line is the Hickok model 246 deluxe color bar generator. Only 8 by 3 inches, 6 inches deep, it has sixteen patterns instead of the five of older models.

For convergence work, there are three cross-hatch patterns; 15 by 21 bar, 7 by 11. and a single "crosshair" patternone vertical and one horizontal line, crossing in the center of the screen. For dots, the same counts, with the last being a single dot. Vertical line patterns have 21, 11 and one bar; the same for horizontal line patterns. These have 15, 7. and one in the middle. These singleline and dot patterns are most useful for finding that "center-dot" and adjusting the centering controls.

For any adjustment, alignment work or signal-tracing in the color section, the standard gated-rainbow 10-bar pattern can be used. The rainbow pattern without gating is also available. There's also a three-bar pattern, consisting of the R-Y, B-Y and G-Y bars, equally spaced.

For making grey-scale adjustments, a blank-raster pattern is provided. You name it, and there's a pattern in there that you need.

The rf-carrier output can be tuned to Channel 2, 3 or 4 with a simple screwdriver adjustment on the front panel. Output is balanced 300 ohm, with clips on a long lead. For signal-tracing and other testing, a composite video signal is also available. This may be modulated with any of the test-patterns. Amplitude of this is ± 2.0 volts p-p. The polarity and signal level can be adjusted by a slide control. The color level can also be adjusted from 0 to the standard 200%.

To make signal-tracing through the

color stages easier, two trigger output pulses can be used for a positive locking of the scope patterns. The horizontal pulse has a pulse-width of $10 \mu s$, the vertical pulse a width of 190 µs. Amplitude of the pulses is +10 volts. This can even be used as external sync with recurrent-sweep scopes, with good results.

If you like to use dots, but are getting old and dim-sighted (like me!) you can make the dots bigger. Just set the DOT ADJ. control on the front panel until the

dot is big enough to see.

The last item on the front panel is the gun-killer switches. These are very handy for making both purity and convergence adjustments. The leads, with insulationpiercing clips, are permanently connected and stowed in the handy compartment on the top of the case. The same compartment contains the power supply and line cord, RF output cable, and there's still room for alignment tools and other things.

That's about all of the dull statistics. The interesting thing about this type of instrument is its construction. IC design is very well suited to this kind of instrument. IC's generate very sharp, clean pulses, count up or down in frequency, and make special pulses of every conceivable shape. The model 246 uses a crystal at 378-kHz, and a frequency-divider IC counts down from this to develop the various patterns. A 3, 563795 MHz crystal, with a tolerance of 0.01%, is used to generate the signal for the rainbow display. So, all the patterns are rock-steady.

Most of the work in the model 246 Deluxe color generator is done by a very special MOS IC, developed by Hickok just for the purpose. It doesn't look too impressive; just an ordinary 16-pin DIP. Inside, however, is a complete outfit of all the digital logic circuits needed for these many functions. This has the equivalent of. 1,000 transistors! Two more stock linear IC's are used for generating the chroma signal and for the rf output amplifiers. Some plain old transistors fill out the list for such things as the dc regulator in the power supply. Incidentally, the dc power supply isn't even on the chassis; it's the black blob on the end of the line cord! This keeps any possible magnetic fields away from both generator and TV set. This has a dual-polarity output of +6.8 volts and -6.8 volts dc, tightly regulated.

Despite the many functions and parts used, this instrument is really "conservative." Its full power consumption is a tremendous ONE WATT!

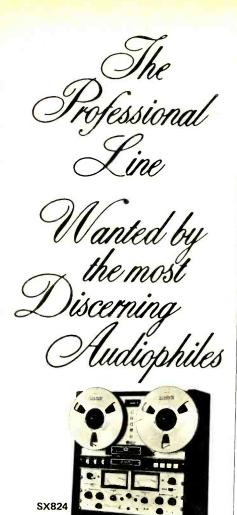
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There is a distinct difference between tape equipment mass-produced by a consumer manufacturer and tape equipment built by a professional audio manufacturer. At Crown International this distinct difference involves five things: over-engineering, rugged construction, hand-crafting, exhaustive testing and conservative rating. After 26 years, Crown is the only remaining original U.S. tape equipment manufacturer still marketing professional quality to discerning audiophiles.

The Crown tape equipment line is designed for audio pros who make their living by recording, to whom an equipment failure at a taping session means money out the window. After four years, when many hi-fi models are traded in, Crown decks still produce recordings with truer fidelity than most new hi-fi decks. No wonder Crowns enjoy such high resale value.

At Crown, each active electronic component, each circuit module and each completed unit is tested from every angle. A tape deck undergoes over 100 hours cumulative testing. Finally, each unit is accompanied by its individual hand entered proof-of-performance report.

For free product data on Crown professional monaural, stereo and quadraphonic tape decks and players, write Crown, Box 1000, Elkhart, Indiana, 46514.



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letters

COMPUTER NEWSLETTER

A few of us in Denver are forming a support group of experimenters in microprocessors, their peripherals and programs. We are interested in providing a clearinghouse distribution service with particular emphasis on the Mark-8 Minicomputer and TV Typewriter. As many are aware, support from manufacturers to the individual experimenter is practically non-existent and comprehensive information exchange is difficult among individuals. We hope that a clearinghouse library service will help alleviate this situation.

The first major areas of interest are: Programs, Programming Aids, Circuits (Extensions and Modifications), Peripherals (TV Typewriter, Cassette Drives, Floppy Disk, etc.), BASIC Compiler Development, Suppliers of Parts and Literature, General Information. Others (as suggested).

We expect to produce a monthly newsletter containing abstracts of what is available and general information. Anyone with an interest in or a contribution/ suggestion for the clearinghouse should send a stamped self-addressed envelope to: The Digital Group Clearinghouse. P.O. Box 6528, Denver, CO 80209.

We hope this service will prove valuable and rewarding to all participants. THE DIGITAL GROUP **CLEARINGHOUSE** Denver, CO

STARLIGHT SCOPE

I really enjoyed the article on the Infrared Viewer in the August issue of Radio-Electronics. I have been building similar viewers since about 1971. I am glad to know that there are other people that are interested in the same things that I am

Fortunately I have been in situations where I could obtain more modern versions of infrared image converter tubes. The 6032 tube is an antique now, but it is available and at a reasonable price.

If you want to see in the dark, the only way to go is with image intensifier tubes that can amplify low light levels like starlight or moonlight. In my quest for better IR tubes, I discovered a company in Van Nuys, California that has surplus image intensifier tubes for sale. The tubes are larger than the 6032. They have 40-mm fiber-optic face plates on both ends of the tube and are about the size of a soft drink can. The fiber optics remove some of the optical distortion inherent in the older tubes with curved photocathode windows.

The image intensifier tubes were originally used in a night vision device

called an Owl Eye. They were used during the Viet Nam war for seeing in the dark, I have built two starlight scopes using these tubes and the results have been amazing. I thought that the IR viewers were good, but the starlight scopes are a thousand times better. Even on the darkest night, there is enough light for the tubes to amplify and make the scene being viewed look like daylight. Really amazing!

Anyway, I thought maybe some of your other readers might be interested in trying to build a viewer that uses starlight or moonlight instead of infrared. The company that has the tubes for sale is: Starlight Engineering, P.O. Box 7426, Van Nuys Main Post Office, Van Nuys, CA 91406

KEN LAWLER Glendale, CA

Thanks for the news, Ken; and while we're on the subject we've received a call from McNeal Electric Equipment Company, 4736 Olive, St. Louis, Mo. 63108. They state that they will supply a kit of parts, SS-8722 that contains 30 1/2-watt carbon resistors for the infrared viewer. It includes 24 100-megohm units; 5 22-megohm units and 1 100K unit. Total price is \$3.00 including postage. -Fditor

CB

Your attention is invited to a copy of the article from the October 1974 issue of the official publication of the International Associations Chiefs of Police. The Police Chief entitled "State Highway Patrol and CB'ers Work Together in Ohio." I am sure that your readers will find the article to be of interest.

While the Citizens Radio Service has many problems, there are millions of citizens who use it properly and regularly for good purposes. And also, the potential of Citizens Band emergency channel-9 is unlimited, especially as more and more local groups and police agencies monitor and respond to calls on channel-9.

After all the information about the bad aspects of Citizens band radio that have been publicized, it is only fair that the public and others such as Hams be informed of some of the good points. A lot is made over the actions of the CB'ers who violate the law, but (as with other things in our daily life) very little is said of the majority of law-abiding citizens who do things the way they are supposed to do.

Actually, even Hams could consider Citizens radio for their own use for contacts with their families, for contacts from their car in highway emergencies

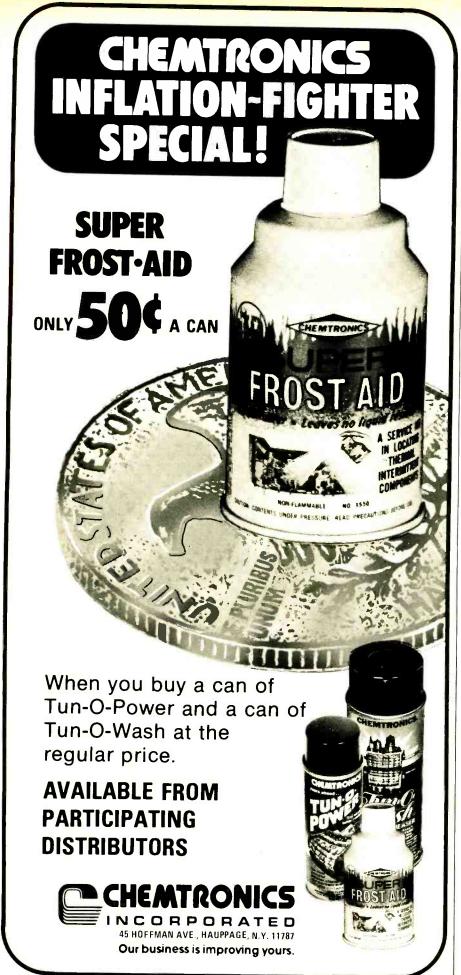
(continued on page 18)

Weller controlled output soldering station

... has interchangeable brains in the form of a ferromagnetic sensor mounted in the tip that controls iron temperature through unique "closed-loop" circuit. Change tips...change temperatures. A Weller exclusive! It's that simple. 600, 700, or 800° F...your choice. Switching tips is always easy because Weller's exclusive triple-plated construction prevents oxidation and "freezing"... assures quick interchangeability. And nobody offers as many tip options. Over 50 combinations of configuration, reach, and temperature, one just right for optimum soldering action and maximum tip life on any job. UL-listed and OSHA-compliant, Weller's Model WTCP-L has its own built-in transformer...24 volt output for operator safety. Non-sinking holder supports and shields the comfort-grip, pencil iron when not in use. Grounded tip guards against static-discharge damage to sensitive workpiece circuitry. Base contains handy, tip-cleaning sponge and receptacle plus off/on switch and red indicator light. And non-burnable silicone power cord prevents annoying self-damage. Weller's WTCP-L Station has all the functional features you need for today's sophisticated soldering...at the most attractive price. No fancy extras that only add to cost. Also available as WTCP-2 for low-temperature service. See it...get it...at your local distributor. Ask, too, about DS-100 de-soldering units. Or request technical information Weller-Xcelite Electronics Division The Cooper Group

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Circle 10 on reader service card



LETTERS

(continued from page 16)

and especially for monitoring at their home to provide a service to the general public. No matter how efficient ham radio is and how useful it is, the hams can't talk to the average citizen while the CB'er can.

The day is coming soon when every automobile will be equipped with a twoway radio at the factory. W. S. DAWSON

Portsmouth, VA

ELECTRONIC MUSIC

Interest in electronic music has grown and because of my wide experience in the medium-both theoretical and practical-I am starting a new journal entitled Analog Sounds. The new journal is based in the art of music and concerns the effect on the art of applied electronics. It will cover a range of subjects including discussions of method, procedure and practical techniques for making music.

Radio-Electronics has been a great stimulus to me in the development of my own creative work with the electronic medium. To help spread the word, I intend including with each issue of Analog Sounds an accumulative directory of relevant articles published in electronic magazines, including yours. This directory will take the form of a subject index with abstracts.

Analog Sounds is a quarterly journal depending solely on readers for support. Anyone interested in further information should contact me.

JACOB MEYEROWITZ Analog Sounds 145 West 55th Street Apt. 6-F New York, NY 10019

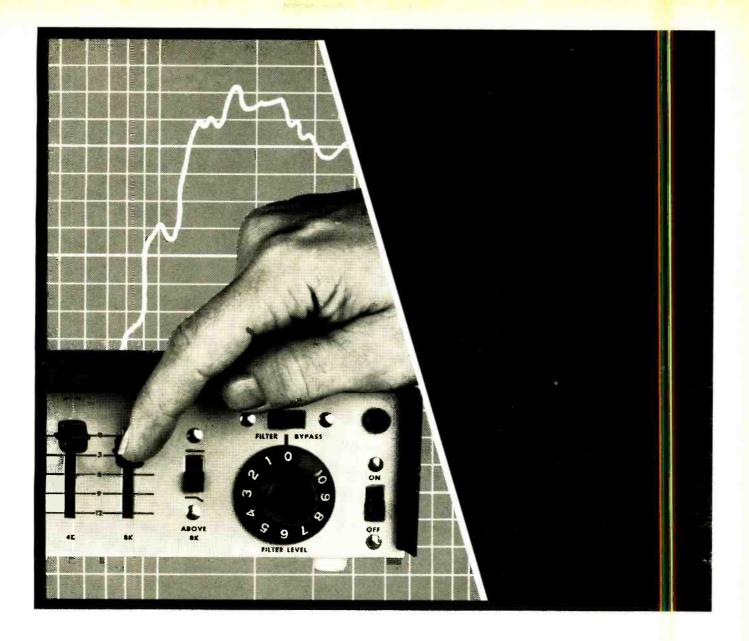
R-E

OLD SCOPE FOR COLOR TV?

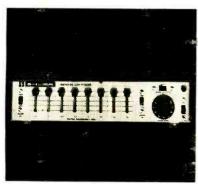
I've got an old scope, in good working order, a 1957 kit model. Do you think it will do for color TV work? Don't know what it will do up around 4-5 MHz.-J.T., Commodore, Pa.

I'd say yes. Get a working color TV set, feed a color-bar pattern into it, and check the critical patterns, Compare these to the ones shown on the schematic. They don't have to be identical, but as long as you know what they look like, fine!

These critical patterns would be: Red, green and blue grids on picture tube; output of burst amplifier; output of 3.58-MHz oscillator, and output of bandpass amplifiers (through detector probe). If you can see a "bar" on the 3.58-MHz oscillator, you do not have to be able to see individual cycles. All you need to know is the p-p voltage. If you can get a good clean pattern at the video detector output, at horizontal frequency, it should do nicely.



The Gain Mutiny.



The gain limitation on most P.A. systems is often dictated by the ring threshold—that is, the point at which feedback sets in. Shure's M610 Feedback Controller suppresses these "ringleaders" before things have a charge to get out of hand. You can achieve significantly higher gain levels before feedback when you add the M610 to any existing system. Its versatile set of filters and roll-off switches smooths out the peaks and valleys in the system's frequency response, allowing you to shape the response to match the characteristics of any room. And, it will fit into a standard 19" audio equipment rack panel with its optional mounting kit. It might just be the essiest way ever for keeping feedback sources in line.

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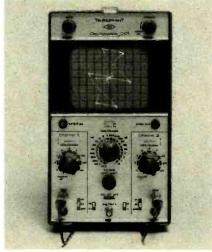
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Circle 13 on reader service card

equipment reports

Telequipment D61 dual-trace scope



Circle 94 on reader service card

"TEKTRONIX" IS A MUCH-RESPECTED NAME in the field of "oscilloscopery," especially in the lab scopes and special units. So, when they put out another line of oscilloscopes, especially for electronics service technicians, these are apt to be pretty good. An example of this is the Telequipment line, originally from England. The model D61 is a good example of these new-generation test instruments. It's a compact, versatile instrument, with a response making it suitable for lab work, and special features for use in entertainment electronics servicing, particularly in color TV, stereo, quadriphonic, and so on.

This is a dual-trace, triggered sweep type, with identical vertical amplifiers having a bandwidth of up to 10 MHz, ac or dc. Risetime is 35 ns. You can do all of the standard tricks such as displaying two signals at once, from a single trigger source. You can also use both channels for making vectorscope patterns; you simply switch Channel 2 to act as the horizontal amplifier. The high bandwidth makes very good vectorscope patterns. As usual, I found this out the hard way. I was trying to make a flower by feeding the blue into the EXT. HORIZONTAL. Didn't work. So, I took a really drastic step; I read the instruction book. A flip of the switch and wham. Easy.

The triggered sweep can be used in NORMAL or AUTOMATIC modes, or externally triggered. A special "Tv" position uses a sync-separator to lock video waveforms firmly. It locks on the vertical sync

pulse for any setting of the TIME/DIV switch up to $100~\mu s/div$, and horizontal sync pulses from $50~\mu s/div$ on up to $0.5~\mu s/div$. (This switching is automatic.) Positive or negative pulses can be selected by the switch, for best lock.

The TIME/DIV (horizontal sweep speed) switch works from 500 ms/div up to 0.5 μs/div (That's one-half of a microsecond.) By pulling the TIMES-5 multiplier switch, the waveform is expanded 5 times for checking any part you need to see. This will give you sweep-speeds up to 100 ns/ div (A nanosecond is 1/1000 of a microsecond.) The trigger is free-running in the AUTO position. You do see a horizontal line on the screen to tell you that the thing's working. For those hard-tohold waveforms, external triggering can be used. For color TV, this is simple; just plug a plain test lead into the EXT TRIG jack, and place it near the deflection yoke cable. This will give you solid lock on anything. All you need is a minimum of 100 mV of pulse.

For either single- or dual-trace work, the trigger-selector switch will trigger the sweep on either the Channel 1 signal, the Channel 2 signal or on the external trigger pulse. For single-trace work, you move the Channel 2 trace off the screen (usually down) and set the trigger selector to Channel 1. This gives you the full height of the screen for p-p voltage readings, probably the most useful of any in TV work.

With modern construction, the matter of test-probe adaptability becomes very important. There are so many tight places that you've got to get into. The D61 uses the well-known "Tektronix probes." These are standard 10:1 low-capacitance type, compensated. There's a jack on the panel for instant checking of this calibration, and another for checking the volts/div calibration. The probe body isn't much bigger than a fountain pen; it has a very sharp pointed tip (result of actual experiment!)

Four special push-on tips are included. One is a plain, fixed hook tip, so that you can hang the light-weight probe to circuit points. The next is a spring-loaded retractable-hook type. This grips leads and connections firmly. The third is a special test-tip for any kind of IC's. It has a U-shaped cutout in the end, with another very sharp point centered in the U. With this, you can get the pattern on any pin of any IC without danger of shorting to adjacent pins. (With the dc position of the vertical amplifier switch,

(continued on page 22)

The New **January**Communications Frequency Counter



\$149⁵⁰

Mobile or Base Operation

THE NDC COMMUNICATIONS FREQUENCY COUNTER operates on 12 VDC or 115 VAC (with optional ac-dc converter). FIVE GIANT LED READ OUTS for easy day and night time clarity. Read out can be seen in bright sun light. FULLY SOLID STATE CONSTRUCTION on printed circuit boards that can withstand hard abuse and shocks. The counter contains a 10MHz TIME BASE for precision accuracy. The counter is easily connected via two SO-239 coax connectors.

FREQ RANGE: 1Hz- 99.999MHz

DISPLAY 5.6" LED

INPUT IMPEDANCE: 1 Meg ohm 40pf

SENSITIVITY: 1 volt in communications mode. With accessory probe 1 microvolt.

OTHER USES AND ACCESSORIES

In addition of being a communications counter, the counter can be used as a precision frequency counter for servicing or measuring unknown frequencys. Two optional accessories are available. Option probe NDC # 1174P converts the counter to a highly sensitive counter capable of reading any signal of one microvolt or more. In addition a 0-300 MHz prescaler is available which converts top counting range to 300 MHz.

ACCESSORY PRICES:

NDC test probe	\$39.95
NDC 300 MHz prescaler	\$49.95
	\$21.95

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Circle 14 on reader service card

(continued from page 20)

you can read logic highs and lows if you want to!)

Last but not least is a simple but very useful one; an insulating cylinder that will let you go right into an open BNC jack and read the signal. Due to the very small center connection of these jacks, this is very hard to do with an ordinary prod. The cables on the standard model are 4.5 feet long; another model is available with a 6-foot cable. The coax used is of a special type, very flexible and made for hard use.

The D61 is all solid state. The CRT is the only tube used. It is a flat-faced 8 x 10 cm type, with a P31 phosphor; a light green and very bright, due to the use of 3.5 kV accelerating voltage. The amplifier circuitry uses innumerable discrete transistors. FET inputs give the vertical amplifiers a very high sensitivity and high impedance.

The acid test of any scope, of course, is "How does it work on the bench?" The D61 passes with flying colors. I used it on quite a few sets, including one Hairy Monster with a difficult color-sync problem. Just to see if I could do it, I put the red-grid waveform on one trace, and the blue on the other, and then aligned the color stages. It worked (Using keyed rainbow source),

For the dual-trace mode, special baselines are provided on the graticule. These are dotted lines. The regular center baseline is a solid line. The vertical attenuators are calibrated from .01 to 5 volts/ cm. With the 10:1 low-cap probes, it gives you a useful range (single channel) from 100 mV/cm to 50 v/cm; since the graticule is 8 cm high, you can read waveforms with a maximum of 400

Controls are well-located and very easy to use. The vertical centering control, for each channel, is the center knob of a dual; the outer knob is the VOLTS/ DIV switch. The TIME/DIV switch's outer knob controls the sweep-speed, and its inner knob is the horizontal positioning for both channels. The switch, intensity and focus controls are above the crt. Once set up, you seldom have to touch these. The rest of the controls are grouped so that they can be very easily adjusted with one hand. The probes plug into jacks at the very bottom of the panel, out of the way.

The triggering of the D61 is very solid; even my pet test waveform, the flattopped comb from a keyed-rainbow color-bar generator, locks in firmly. This one has so many almost equal-amplitude peaks that it's tough to hold; the D61 grabbed it and held it!

With some of the things they're throwing at us now-IC's, modules, digital equipment, and so on and on, we are going to need good test equipment to handle them rapidly and accurately. The Teleguipment D61 fits this description very well. By the way, I was very pleasantly surprised when I compared the price of this instrument to others of similar spec's. One of the fringe benefits of this job is getting to work with a lot of fine test-equipment. I certainly got my jollies out of this one.

Castle "Master Subber" Mark V TV Signal Circuit **Analyst**



Circle 95 on reader service card

THE FASTEST AND EASIEST WAY TO FIND trouble in TV circuits is to feed in a normal test signal, then note the output. Normal output means that this stage is good. No output or abnormal output means that you've found the trouble. This is also the oldest way; we were using it with John F. Rider's "Servicing By Signal Tracing" back in the late 1930's! For any kind of signal testing in color or B/W TV, an instrument like (continued on page 24)

More for your money - \$199.00* - than any other Color Bar/Pattern Generator

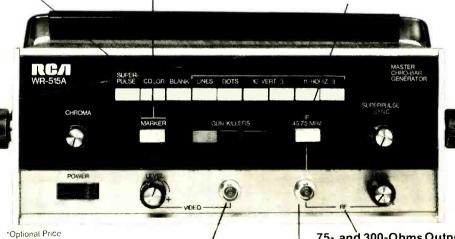
Superpulse — Provides a big, fat square pulse for easy CRO tracing in the set, and a white window pattern for quick checks of gray-scale Bar Marker — Identifies tracking, smearing, and ringing right on the TV screen.

color bars, 3, 6, 9 - a "must" on overscanned sets.

IF Output — at 45.75 MHz for troubleshooting in mixer and IF stages. Excellent for servicing "modular" solidstate sets.

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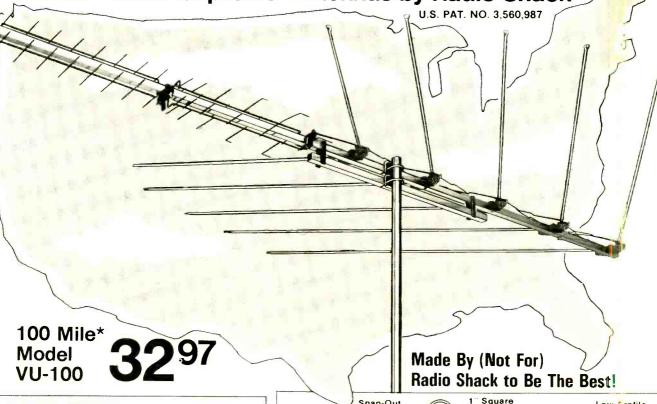


2 volts. Video Output max. "+" and "-" at 75 ohms for commercial/industrial closed-circuit TV.

75- and 300-Ohms Output -at bothRFand IF. Snap-on BNC heads for fast impedance changes. RF works into MATV, CATV systems.

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There's a Color Supreme to Meet Your Reception Needs — Near or Far

	Range in Miles*		Boom	No. of		
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VU-75	75	50	50	50"	14	17 97
VU-90	90	60	60	80"	23	26 37
VU-100	100	90	90	100"	32	32 37
VU-110	110	90	90	120"	34	42 97
VU-150	150	90	90	150"	35	5137

*Ranges based on reception over flat, open terrain

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Circle 16 on reader service card

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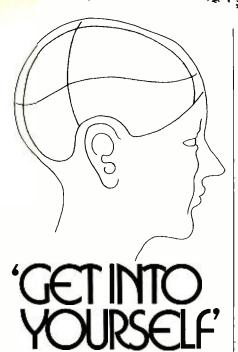
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EQUIPMENT REPORT

(continued from page 22)

Castle TV's "Master Subber Mark V" is invaluable.

The original Tuner Subbers were and are very useful. They will check out tuner and i.f. troubles. The Master Subber Mark V, will provide normal test signals for every signal-circuit in the set! It is a deluxe Tuner Subber, with 40-MHz i.f. output. This will check the tuner and i.f. stages. There's more: it also has not one but two video signal outputs, positive and negative going sync. So, you can match any type of detector circuitry. With a color program on the input, these signals also have the color informataion, so that this can be used for checking out bandpass amplifiers, demodulators, etc. (Want a fixed pattern instead of a TV station signal? Just feed rf output of your color-bar generator into input of Master Subber!) These video outputs can be up to 7 volts peak; so they will drive almost any video amplifier stage.

Check the sound stages? Sure. The unit has a 4.5-MHz sound i.f. output; this checks the sound i.f. and FM limiter stages. There is also an audio output, up to 500 mV, for direct testing of audio stages after the detector. This is also fed to a small built-in speaker in the Master Subber's cabinet; it has its own volume control, so that you can turn it off if you don't need it.

This instrument can be used to check antennas. By hooking it to the leadin, you can tell instantly whether you have a suitable signal-level. This can be done in two ways; one, listen to the TV sound from the built-in speaker. Two, watch the video-carrier level meter on the front panel. If you want to, you can calibrate the reading of this meter, at a certain

setting of the MASTER GAIN control, with a field-strength meter. If this is set to a certain reading at 1000 microvolts (standard level for most CATV systems), you can also check CATV and MATV systems. This is very useful in cases where that old question "Is it the set or the antenna?" arises. In strong-signal areas, where the set's on rabbit-ears, etc., you can check, just the same. The MASTER SUBBER has its own built-in monopole antenna which telescopes into the case.

All of these functions are built into a compact plastic case, no bigger than the original Tuner Subber. Power is supplied by two 9-volt alkaline batteries, or by a 120-Vac plug-in power supply; this automatically disconnects the internal batteries when used. A LED pilot light tells you when it's on.

One essential thing with an instrument like this is the correct output cables, so that it can be hooked to any type of set with no trouble. They are here. Four separate "Mastermatch-coupler" cables are included, some with "RCA Phono jack" terminations, both male and female, others with alligator clips (color coded), and so on. If greater length is needed, one can be plugged into another to reach hard to get-at places.

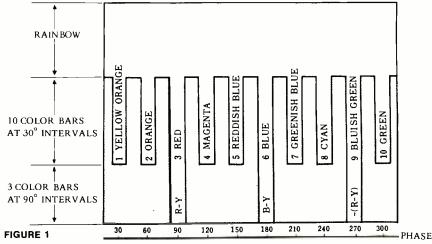
Dame Fortune makes it easy for me to test test equipment! This time, she provided me with an elderly Motorola B/W with indeterminate problems. Subbing the tuner didn't help. Subbing the video didn't help. I checked the sound. Something finally worked! The trouble eventually turned up in the contrast control on the video output stage! So, I got a chance to use all of the many functions of this versatile instrument at once, and it worked to perfection. All parts of any TV set, color or B/W, tube or solid state, or modular, can be checked quickly and accurately with "real TV" signals. Very useful indeed.

Leader LCG-395 universal color bar pattern generator

Circle 96 on reader service card

THE LATEST OFFERING FROM LEADER Electronics Corp. is a bar-dot generator with some interesting features. Built with IC's, this compact instrument provides the service technician with some unusual and quite handy patterns.

The color-bar pattern (see Fig. 1) is basically the standard 10-bar keyed rainbow. However, the color-bar pattern is unusual in that it's divided into thirds. Across the top of the screen is (continued on page 30)



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25

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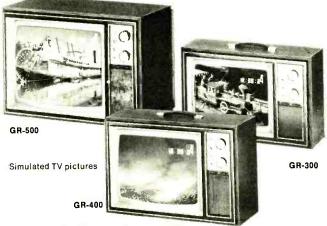
Kit CH-106814.95'



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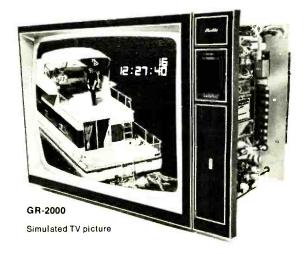
Kit GR-1075129.95*



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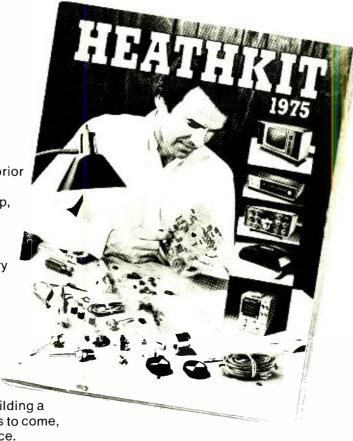
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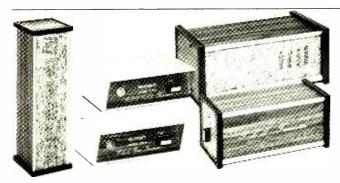
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an unkeyed rainbow pattern. The center of the screen contains the standard 10-bar keyed rainbow, and the lower third of the screen is a spaced threebar pattern with R-Y, B-Y, and R-Y (Cyan or light green) color-bars. It sounds odd, but in use it can be very handy.



There is a white raster pattern for setting grey-scale and checking for hum bars in the video. Next comes another new pattern called a "window". It's a white rectangle in the middle of a black border and is used for checking the display pulses (sag, overshoot, ringing). After this, a "staircase" pattern which contains a black bar across the top third of the screen. The rest of the screen is made up of five equal-size vertical bars, of 20, 40, 60, 80 and 100% (white) modulation. This can be used for checking video response and contrast.

The convergence pattern (See Fig. 2) has some handy features. It's a

overscanned in either direction, etc. For the final touch, there is a small set of 6 dashes in the lower right corner. This is a "corner marker" which tells you whether the deflection yoke is hooked up with the right polarity. If this marker isn't in the lower right corner, something needs reversing.

A set of gun-killer leads, switches and clips are provided. All of the gunkiller and pattern-selector switches are generous-sized bushputtons. The RF output may be taken from either 300ohm balanced or 75-ohm unbalanced jacks. Output signal level is controlled by the RF adjustment, RF output can be set to Ch. 5 or Ch. 6 by a selector switch on the front panel. This switch also provides for the use of a 40-MHz video i.f. output for direct injection into the i.f. input, a useful feature for checking the tuner.

A 75-ohm video signal is also available at a front panel jack. Polarity and level (max. 10 mV) of this signal can be set by the VIDEO CONTROL. A trigger signal for signal tracing with a scope is also provided for on the front panel. This can be of either horizontal or vertical frequency, or a composite. This has an open-circuit voltage of about 3 V p-p.

The last control on the front panel is marked "Brightness". It does control the brightness of all patterns except for the staircase, which is fixed. It also acts as a "color" control for the color-bar pattern, with the normal range of 0-200% saturation.

The LCG-395 is a compact instrument, only 3" high by 8" wide, with a

SAFETY ZONE MARKERS CROSSHATCH DOTS VERTICAL CENTER SAFETY ZONE MARKERS HORIZONTAL -CENTER 80% 100% FIGURE 2 CENTER DOT CORNER MARKER

crosshatch with 10 horizontal and 7 vertical bars. This is only the beginning! Inside this is another pattern made up of dashed lines. There is a horizontal and vertical cross with a "center dot". Around the edges of the pattern is a "safety zone" dashed-line pattern. This shows you instantly whether the raster is centered, linear,

heavy bail-type handle that serves as a stand for bench use. Long standoffs are provided on the back, for storing the line cord or for use as legs if you want to use it in a vertical position. All controls on the panel are clearly marked, with lines going to the associated jack. All pushbuttons are big enough for easy use.

Why You Should Buy Telequipment

Telequipment products are designed to meet the needs of the cost-conscious buyer without sacrificing reliability or general utility.

The Telequipment line of Tektronix oscilloscopes combines low price with a number of features not usually found in other oscilloscopes of the same price range. Features such as calibrated sweep rate and vertical step attenuators, variable controls, triggered sweep, probe-calibrated outputs, illuminated graticule and TV-field or line triggering, make these instruments versatile and easy to use.

The 10 MHz, dual trace, D61 is exceptionally easy to operate and low priced at only \$545. Its stable triggering characteristics, front panel simplicity, and versatility make it an excellent choice for industrial and educational applications. X-y analysis vector capability and TV line or frame triggering also make it especially well suited for service shops.

The Telequipment line, in addition, includes the S51B, a single-trace, 3 MHz oscilloscope with either automatic or normal trigger modes—at \$325, the lowest priced oscilloscope offered by Tektronix—and is excellent for use in audio to medium frequency applications. In addition, there's the DM 64, a 10 MHz dual-channel, bistable storage oscilloscope for \$1195, and more...

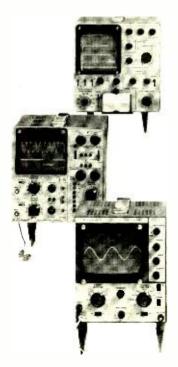
... The D67 oscilloscope at \$1125 combines dual trace, the 25-MHz bandwidth at 10 mV/div, FET inputs, regulated power supplies, and all solid-state circuits with delayed-sweep capability—a combination of features seldom found in a low-priced oscilloscope. The D66 offers all of these features except delayed sweep at an even lower price, \$875. Both feature a SUM mode with normal/invert capability that improves display of small signals in the presence of common mode noise. The easy-to-operate CT71 curve tracer enhances the line providing a dynamic semiconductor measurement capability by displaying characteristic curves of transistors, FETS, and diodes

Available at only \$895, it is well suited for industrial application and student labs.

For more information about Telequipment instruments, contact your local Tektronix Field Office, or write Tektronix, Inc., Beaverton, Oregon 97077. In Europe, write Tektronix Limited,

P.O. Box 36, St. Peter Port, Guernsey, Channel Islands. In Canada, write Tektronix Canada Ltd., Quebec, Canada.













Circle 20 on reader service card

Circle 30 on reader service card for demonstration

31

Another advance in tube technology from RCA

RCA, the leading manufacturer of receiving tubes, offers you advanced types to satisfy the needs of the replacement market. We can do this because RCA has unique design capability that comes only with years of tube design and manufacturing experience. This means that when you install RCAmade tubes, you're selling quality tubes with the newest and best innovations in design and performance.

A dynamic approach to receiving tube technology, geared to the rigorous demands of the replacement market, RCA's exclusive, new 6MJ6/6LQ6/6JE6C brings added reliability to horizontal deflection cir-

cuits, the most critical in your customer's set. Manufactured exclusively by RCA, this new rugged horizontal output tube with the integral envelope-top-cap assembly, which totally eliminates loose top-cap problems, represents another significant advance in tube technology from RCA.

You can be certain that RCA will continue to lead the way in the receiving tube business. After all, your tube business is our tube business and we expect to share this high volume business with you for a long time to come.

See your RCA distributor for all of your tube needs.



Rugged Features of the 6MJ6/6LQ6/6JE6C

- Integral-Envelope-Top-Cap Assembly
- Rigid Cage
- Stable grid alignment
- Excellent Heat Dissipation

RСЛ

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

20 easy-to-build COSMOS burglar alarms - part 1

These burglar alarm circuits are simple yet very effective. Many options exist for each circuit, so the final circuit you build is entirely your own choice.

by R. M. MARSTON

A BURGLAR ALARM IS THE MOST VALUable piece of equipment that the electronics buff can build for use in the home. It helps give the owner peace-of-mind when the house is empty, and gives a high degree of protection against theft of property or damage. It may even help protect the owner's life.

The requirements of the ideal burglar alarm system are stringent. The system must be immune to giving false alarms. It must be battery powered and consume negligible standby current. It must be capable of driving almost any type of alarm generator (bell, siren, etc.). Finally, the system must be versatile enough to meet the differing needs of individual owners. It should, for example, be capable of providing either self-latch or autoturn-off operation, and have provisions for incorporating 'panic' and other facilities.

In Part 1 of this series, we show how you can use modern COS/MOS (COmplementary-Symetry Metal-Oxide Silicon) digital integrated circuits to build tailor-made burglar alarms which meet all of the requirements outlined above. These alarms can be as simple or as complex as you want to make them. Later in the article we'll show how you can make your own 10-watt alarm-call generators to use in place of alarm bells or sirens, and we'll give advice on how to select alarm sensor installations to suit your own home.

Basic alarm circuits

The simplest and most widely used type of burglar alarm circuit consists of a number of switches or other sensor devices wired to doors, windows, etc., The output of these sensor devices are used to trigger an alarm bell via a self-latching relay. The sensor devices may be the normally-open (N.O) type of switches or reed-relays which activate the alarm when they are momentarily closed, or they may be normally-closed (N.C) type of switches or lengths of wire or foil which activate the alarm when they are momentarily opened or broken.

Figure 1 shows a practical burglar alarm circuit using a normally-open type of sensor. During normal operation, when switch S2 is in the STANDBY position and sensor switch S1 is open, the relay is de-energized. When S1 is momentarily closed, it connects the relay coil (RY1) directly across the supply lines, and the relay is energized. As the relay contacts RY1-2 close and activate the alarm generator, contacts RY1-1 close and short out sensor switch S1, thus latching the alarm generator on. Any number of normally open sensor switches can be wired in parallel with S1 and used to activate the alarm system from different parts of the house.

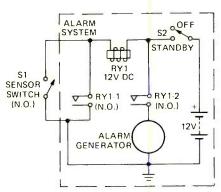


FIG. 1—BASIC BURGLAR ALARM CIRCUIT using normally-open sensor switches.

The advantages of the Fig. 1 circuit are that it is simple, virtually immune to giving false alarms, consumes zero standby current, and is capable of driving any type of alarm generator via relay contacts RY1-2. The disadvantages of the circuit are that it can be simply disabled by cutting the leads connecting S1 to the input of the alarm system, and the system lacks vers. tility.

An alternative basic type of burglar alarm circuit is in Project 1. This is a practical burglar alarm circuit using normally-closed sensor switches. During normal operation, when switch S2 is in the STANDBY position, the baseemitter junction of transistor Q1 is shorted out by sensor switch \$1 so Q1 is cut-off and the relay is de-energized. A standby current of 1-mA flows through resistor R1 under this condition. When sensor switch \$1 is momentarily opened, base current flows into Q1 via R1, driving the transistor into conduction and energizing the relay. When the relay is energized, contacts RY1-2 close and activate the alarm generator, and contacts RY1-1 close and short the relay directly

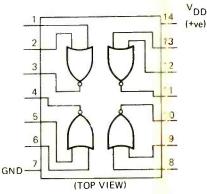


FIG. 2—PIN CONNECTION diagram of the CD4001AE quad 2-input NOR gate IC.

across the supply lines, thus latching the alarm generator on. Any number of n.c. sensor switches can be wired in series with S1 and used to activate the alarm from different parts of the house.

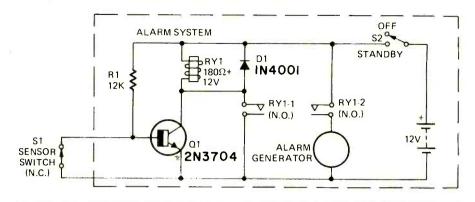
The major advantages of the Project 1 circuit are that it is simple, virtually immune to giving false alarms, can drive any type of alarm generator, and is difficult to disable-since it can be disabled only by shorting out the sensor switches or the leads connecting S1 to the input of the alarm system. The greatest disadvantage of the system is that it consumes an appreciable standby current (1-mA). A less serious disadvantage is that the basic circuit is lacking in versatility, although it should be noted that the design can be made to function simultaneously as both a make-to-operate and a breakto-operate alarm by simply wiring normally closed sensor switches in series with S1 and normally open sensor switches in parallel with relay contacts RY1-1.

Finally, Project 2 shows the practical circuit of a simple COS/MOS-aided relay burglar alarm that can be activated by both normally open and normally closed contact sensors. The COS/ MOS IC used in this circuit (and all the remaining circuits described in this article) is a CD4001AE quad 2-input NOR gate, manufactured by RCA. The basic circuit and pin connections of this IC are shown in Fig. 2. Each of the four gates of this IC feature a near-infinite input impedance, virtually zero standby current, and a low output impedance. In the Project 2 circuit, only one of the gates is used, and is connected as a simple inverter. All the unused inputs of the remaining three unused gates are tied to ground, as indicated in the diagram.

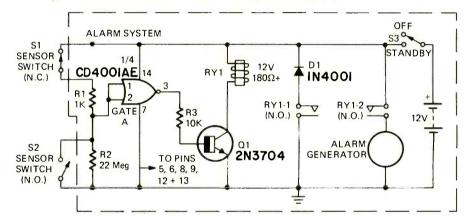
The circuit in Project 2 works as follows. During normal operation, when switch S3 is in the STANDBY position and sensor switch S1 is closed and sensor switch S2 is open, the input of gate A is held close to the positive voltage level via the voltage divider R1 and R2, so the output of the gate is at ground potential, and transistor Q1 is cut-off and the relay is de-energized. A standby current of only a microamp or so flows in the circuit under this condition (via R1-R2, and via the leakage resistance of Q1).

When sensor switch S1 is momentarily opened or sensor switch S2 is momentarily closed, the input of gate A is pulled to ground potential via R2 or S2, and the output of gate A immediately switches to the positive rail voltage and drives transistor Q1 into conduction and energizes the relay via resistor R3. When the relay is energized, contacts RY1-2 close and acti-

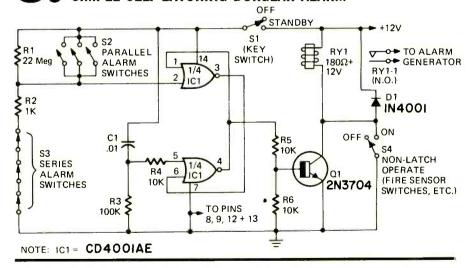
BASIC BURGLAR ALARM CIRCUIT



2. ALARM CIRCUIT USING COS/MOS LOGIC



3 SIMPLE SELF-LATCHING BURGLAR ALARM



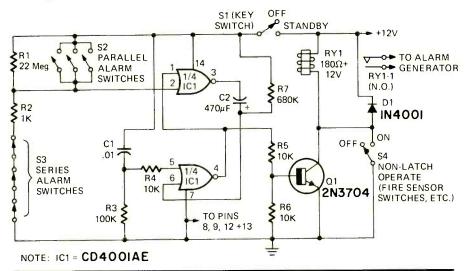
vate the alarm generator and contacts RY1-1 close and short the relay directly across the supply lines, thus latching the alarm generator on. Any number of n.c. sensor switches can be wired in series with S1, and any number of n.o. switches can be wired in parallel with S2.

The advantages of the Project 2 cir-

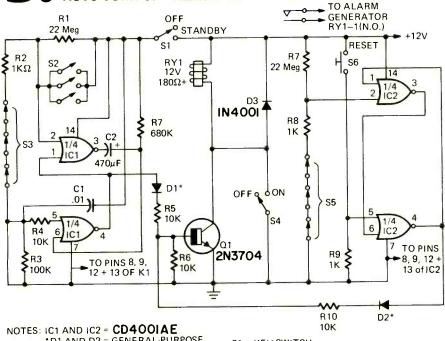
cuit are that it is reasonably simple, virtually immune to giving false alarms, is difficult to disable, can drive any type of alarm generator, and is very versatile. Its versatility comes from the fact that gate A can readily be used in a variety of modes, and forms only one quarter of the number of available gates in the CD4001AE COS/MOS

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AUTO-TURN-OFF BURGLAR ALARM



AUTO-TURN-OFF ALARM WITH "PANIC" FACILITY



*D1 AND D2 = GENERAL-PURPOSE SILICON DIODES

S1 = KEY SWITCH

S2 = N.O. ALARM SWITCHES, IN PARALLEL S3 = N.C. ALARM SWITCHES, IN SERIES

S4 = N.O. FIRE-SENSOR SWITCHES

'PANIC' BUTTONS, IN SERIES

S6 = N.O. 'RESET' BUTTON FOR PANIC ALARM

package. The four available gates can readily be interconnected to act in a variety of gate, logic, time delay, and multivibrator modes, and can be used to give a variety of useful alarm facilities.

The Project 2 circuit has no significant disadvantages, and forms the basis of all the practical alarm projects described in the remaining parts of this article.

Practical COS/MOS alarm circuits

A practical alarm system may be of

either the self-latching type, which turns on as soon as it is activated and then remains on indefinitely, or it may be of the auto-turn-off type, which turns on as soon as it is activated but then turns off again automatically after a pre-set period. COS/MOS alarm systems of both these types are shown in Projects 3 and 4.

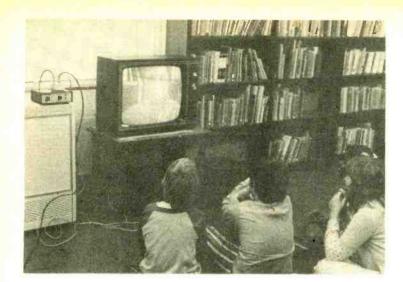
The self-latching operation of the Project 3 circuit is obtained by wiring two of the 2-input NOR gates of a CD4001AE IC so that they act as a simple bistable multivibrator. The action of this bistable is such that its output (taken from pin 4) goes low and self-latches when a positive voltage or pulse is applied to pin 5, and its output goes high and self-latches when a positive voltage or pulse is applied to pin 2. Power is applied to the bistable and to the alarm sensor switches (S2 and S3) via key-operated switch S1.

Assume, then, that alarm sensor S2 is open and \$3 is closed. Wher keyswitch S1 is first set to the STANDBY position, pin 2 is held low by the voltage divider R1 and R2, and a brief positive voltage pulse is fed to pin 5 from the supply line via C1 and R3-R4. Consequently, the output of the bistable automatically goes lcw as soon as S1 is closed. Under this condition, zero base drive is applied to transistor Q1, so Q1 is cut-off, the relay is de-energized and the alarm generator is off. The circuit draws a typical current of about 1-µA in this standby mode. Half of this current flows through the supply lines via R1 and R2, and the other half flows via the leakage resistance of transistor Q1.

The alarm can be activated by opening any one of series-connected sensor switches S3, or by closing any one of parallel-connected sensor switches S2. Under this condition, pin 2 of the bistable goes close to the positive supply voltage and the bistable changes mode and its output locks into the high state and switches the alarm generator on via transistor Q1 and the relay. The alarm then stays on indefinitely, and can be turned off only by opening key switch S1.

The auto-turn-off circuit of Project 4 is similar to that of Project 3, except that in this case the two gates of the IC are connected as a simple monostable multivibrator. The action of this monostable is such that its output goes to the low state when a positive voltage or pulse is applied to pin 5, but goes high for a pre-set period when a positive-going voltage transition is applied to pin 2. The value of this pre-set period is determined by the time constant of R7 and C2, and equals approximately four minutes (0.5 s. per μF of C2) with the C2 value shown. At the end of this period, the output of the monostable automatically switches back to the low state. Note that the monostable can be triggered only by a positive-going transition voltage applied to pin 2, and its action is not influenced by constant high or low voltages that may be applied to this pin.

Thus, the output of the monostable automatically goes low as soor as key switch S1 is set to the STANDEY posi-(continued on page 88)



Add GGTV to MATV

Adding closed circuit television to an MATV system is not difficult. Here's how to do it.

> by JAMES E. KLUGE TECHNICAL EDITOR WINEGARD COMPANY

IT'S EASY TO ALLOW FOR FUTURE EXpansion of, say, an apartment or condominium complex from 500 to 1,000 units. Judicious over-specification in the design of its MATV system can take care of most future expansion requirements. But the MATV designer who must plan a system capable of many more functions than mere distribution of off-the-air signals has a problem. Fortunately, he also has help —if he knows where to look.

Several manufacturing companies have taken a penetrating look at the potentials of MATV and CATV systems and have provided components to take advantage of those potentials. These components accept video and audio signals from almost any source, such as a TV camera, videotape or film chain, FM tuner, tape or record player and convert this input into a complete television signal. To accomplish this, the minimum components are an audio-video modulator and a sub-channel converter. A switcher can be added if multiple inputs are to be accepted.

Signal path

Let's follow a hypothetical signal from its origin through the system until it shows up on the TV screen. Winegard Company components are used for convenience, although others are available.

A low-cost TV camera can monitor, say, the swimming pool and adjacent area. If sound is desired, any standard microphone may be used. These video and audio signals are input to a Model IV-505 Audio-Video Modulator which combines them to produce a complete 6-MHz sub-channel television signal. This sub-channel lies in the range between 18 and 48 MHz to avoid interference with standard frequencies on the trunkline.

The IV-505 introduces this sub-

channel signal into the trunkline system via an institutional-type wall tap. When it reaches the head-end, the subchannel signal is picked off by a Model SVC-601 Converter/Strip Amplifier which converts it to the standard frequency of an unused vhf channel and reintroduces the signal into the trunkline system for distribution.

So, to check on whether little Susie Smith is at the pool, all her mother has to do is flip the TV tuner to, say, Channel 10.

There are two basic ways to handle multiple video inputs. the fiirst way is to use a separate set of components (IV-505, SVC-601) for each camera and microphone. This gives separate sub-channel conversion for separate vhf channel display. This is more expensive, both in terms of money spent on components and use of available vhf channels, but it does allow simultaneous coverage of different areas, such as pool and tennis courts.

Programming can be originated at any point within such a multiple dwelling complex, just as long as there is an institutional-type tap nearby. Obviously, such a set-up has dramatic potential for two-way communication within CATV systems, too.

The second way would be to use a pair of switchers (VS-401 Video Selector) for sequential coverage of up to four areas in a single sub-channel for single vhf channel display. Of course, if tenants can tolerate pictures without "live" sound, a single VS-401 could provide for sequential coverage of up to four areas, and background music could be fed directly into the IV-505 from another source such as a tape deck.

The beauty of the whole concept is that no additional trunkline is needed. The IV-505 feeds audio or video inputs right into the existing trunkline. So what was previously merely an MATV distribution system becomes a

closed circuit TV system on selected vhf channels.

Is it worth it

Why would anyone want to turn an existing MATV system into an inhouse closed circuit network? There are three sets of pressures on the MATV industry today. All three come from outside the industry, and they are just now beginning to be felt.

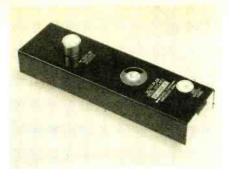
One pressure comes from the socalled "communications explosion," which is far from being over. Developments in the late 60's were only the initial shock wave, and the main blast is yet to come. During the last decade, the general public's relationship with the rest of the world has been drastically altered in unforeseeable ways. As a result, the demand for communication seems nearly insatiable. The more information we get, the more we want.

Another pressure is the growing acceptance of multiple unit housing, the very thing that has made the MATV industry as big as it is today. Vast numbers of Americans have suddenly realized that they can achieve the lifestyle they want for a lot less money than they figured. This relaization has sparked a widespread upheaval in housing patterns, as the construction industry is well aware.

There was a time when you had to have millions (and live near the country club) to enjoy luxuries like private swimming pools, tennis courts, golf courses and recreational areas, all on your grounds. Throw in garage parking, social centers, barber and beauty shops, plus a private security force to watch over all these, and it sounds like some millionaire's estate. Yet these conveniences, once the exclusive property of the very rich, today are enjoyed by a large number of middle-class Americans.

Promoters of these multiple-unit





WINEGARD'S MODEL VS-401 video selector is designed to switch one of four video inputs to a single output.



WINEGARD'S MODEL SVC-601 converter strip amplifier mounts directly on the Ultra-Plex power panels.

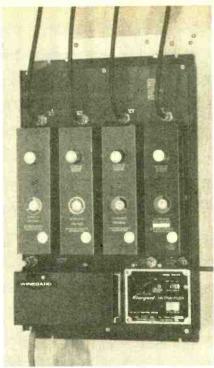
housing complexes have offered an extravagant variety of inducements to prospective renters. What more can they offer in order to fill their apartments and keep them filled?

An obvious answer is the extended use of existing MATV systems for their tenants convenience. A couple of years ago, this might not have been practical, but a third development has made it economically feasible.

That third development is the cost of video cameras, which keeps edging lower and lower. Only a few years ago, you couldn't touch a decent TV camera for under a thousand dollars. Today, a camera with the same capabilities can be had for around \$100. This trend makes it practical for MATV system owners to provide their tenants with a wide variety of services through their TV receivers.

These services can include the monitoring of critical areas, such as entrances, swimming pool, restaurants and shops; entertainment, including replay of earlier programming at a more convenient time, as well as tapes on every conceivable subject drawn from extensive libraries developed for the purpose; and capsule information about the environment that the apartment dweller must cope with. Although it won't supplant regular news shows, such capsule information would contain such items as the weather, stock market news, traffic conditions and headline news stories, all recycled at a rapid rate.

This amounts to "in-house" origination, and it implies that the system



WINEGARD'S MODEL DSX-415 Ultra-Plex deluxe 4-strip power panel supplies power for the Ultra-Plex plug-in modules.

should have the capability for distributing the desired signals on channels not occupied by standard broadcast.

The equipment

Since the locally introduced signal has to "swim upstream" to get to the head end for distribution, it must not interfere with off-the-air signals coming "downstream." That's why the IV-505 translates the signal it receives from cameras, VTR's or audio equipment to one of three sub-channels between 18 and 48 MHz before introducing it into the trunkline.

Subchannel A covers 42 to 48 MHz and will convert to any vhf channel except 4 and 6. Subchannel C covers 30 to 36 MHz and converts to any vhf channel except 3, 4, 12 and 13. Subchannel E covers 18 to 23 MHz and converts to any vhf channel except 2, 5, 6, 10, 11, 12 and 13. None of these sub-channels will cause interference in the vhf range, particularly at the modulator's output of 58 dBmV on the +12 Vdc level.

The SVC-601 converter/strip amplifier that accepts the modulator's output and up-converts it to one of these vhf channel frequencies plugs right into the Ultra-Plex power panel at the head end. Once the sub-channel and vhf channel have been specified, the only further adjustment is in the age threshold control. It allows output levels to be set between 46 and 57 dBmV, to bring the output into alignment with other vhf channels in the distribution system.

The simple addition of a video selec-

tor (Model VS-401) makes available any one of four video inputs to the modulator, achieving great programming flexibility.

So, even though an Ultra-Plex MATV system may have been designed originally only for top-quality off-the-air signal distribution. It can be quickly expanded to add closed-circuit capabilities with these few modular components.

This kind of product isn't exclusive with Winegard, of course. Severa other manufacturers have similar components in their lines. What sets Winegard's apart is the way it can be integrated into the Ultra-Plex modular system inexpensively and at any future time.

At the time that Winegard introduced their Ultra-Plex line, the plug-in modules such as band separators and strip amplifiers seemed like the ogical way for the designer and instaler to get maximum results with minimum effort. It is generally recognized that it is better to separate charmels or bands and to process the signals separately before recombining them for distribution via the coax system. What Ultra-Plex did was to turn this expensive design approach into an Boonomical one, given the high cost of time and materials. And it opened the door for using every channel in the vhf range, with less chance of cross-modulation and more control over the signal level delivered to the individual receiver.

Each IV-505 modulator accepts any standard video output from cameras or video tape recorders, and audio from most dynamic microphones, AM-FM tuners, tape recorders and record players. Its output is crystal controlled (.005%) on one of three factory tuned subchannel frequencies. The choice of whf channel for the output determines which of the subchannels in the 18 to 48-MHz range must be used. Controls include an audio mode selector, video level control (75 to 100% modulation) and audio level control.

The SVC-601 converter/strip amplifier converts the modulator's output to a specified vhf channel frequency. Its age system provides constart output level of 0.7 volt (57 dBmV) with input level variance up to 14 dF. This output level is adjustable between 46 and 57 dBmV. It also accepts a plugin 15 dB booster for cases where high losses are incurred in returning subchannel signals to the head end

The converter/strip amplifier plugs in directly to the DSX-250 or DSX-415 Ultra-Plex power panels. The audiovideo modulator takes uhf type PL-259 video input connectors, Amphenol 70 Series audio input connectors and 75-ohm F type output connectors. R-E

Audio Signals You

Here's an audio problem that you may causing it. The problem is called audio picked-up, rectified and amplified by audio

by LEN FELDMAN

CONTRIBUTING HIGH-FIDELITY EDITOR

RECENTLY, A FRIEND OF MINE ASKED ME to appear on his weekly radio show in New York to discuss audio in general and events at the recently held New York Hi-Fi Show in particular. Since the show is taped in advance (as most talk shows these days are), I suggested that we do the taping at my laboratory and that my friend simply bring along two of his favorite microphones, since I had the necessary tape recording equipment with which to make a Dolbyized master tape of the interview. We had followed this practice on many previous occasions and were so confident of the results that, satisfied with the content of the interview, we never even bothered to play back the tape before my radio host left for his own studio to incorporate the interview into his hour-long musical show.

It was only after I heard the show on the air that I learned that my friend had to painstakingly re-do his "track", carefully fitting in and synchronizing his questions with my previously recorded answers. The extra work had taken him several hours and, much to his credit, even I could not detect the fact that his questions and my answers had been recorded days apart. Such are the miracles of modern tape recording. More recently, he gave me the original master tape and when I listened to it, I understood why he had to "fake" the session in that way. On his voice track (and ONLY on his voice track). there appeared almost continuously the garbled voice of my next door neighbor who is a dedicated radio amateur operator. While completely unintelligible, the raucous interference was no more than about 10-dB below the desired program material we had recorded. The youngster next door invited me to check out his equipment. Doing so revealed no illegal radiations and, in fact, his little station was a model of good radio amateur practice. All of which leads me to the subject called "audio rectification"-one of the most troublesome forms of interference common to a great many hi-fi audio systems. It manifests itself in the form of received radio signals when listening to your phonograph and has also been known to occur when using hearing aids, public address sound systems and even electronic organs. At a recent meeting of the audio sub-committee of the EIA (Electronic Industries Association), a proposed draft of a consumer products engineering bulletin was circulated which deals with this problem.

As the bulletin points out, because of the proliferation in the past few years of rf transmitting equipment (AM, FM, TV, radar, radio amateur, Citizens band, etc.), cases of audio rectification are becoming too frequent, and the cost of correction too high, to ignore this interference in the original design of audio equipment.

As defined by the EIA bulletin, audio rectification is rf energy from any sort of transmitter being received by an element in an audio amplifier. This rf energy is then rectified by the audio amplifier in any non-linear active element such as a vacuum tube, transistor or integrated circuit. The rectified signal is then amplified by the remainder of the audio amplifying circuits and appears as an unwanted signal at the speaker's output terminals.

FCC recognition of the problem

The Federal Communications Commission has been aware of this growing problem for some time, but so long as the source of rf energy (be it a transmitter or any other device which emits rf) is operating "within specs", the solution must be sought by the owners of the audio equipment. Some years ago, the FCC issued a brief bulletin which included two schematics showing possible additions that might be made to audio circuits to cut-down the audio rectification problem. The first

of these diagrams is reproduced in Fig. 1 and applies primarily to tube equipment.

This early bulletin suggests such modifications as bypassing the speaker output terminals to chassis ground with 0.01 µF disc capacitors, lowering of the input resistance (R1) to the first tube stage and bypassing that resistor with a small disc capacitor (about 500 pF), adding a series 75K resistor (R2) in series with the grid to form a sort of simple low-pass filter network. Additional suggestions in this bulletin applying to ac-dc equipment include the addition of a 0.001-µF disc capacitor from the heater line to the chassis and bypassing both sides of the 120volt ac power line with 0.01-μF disc capacitors.

Suggestions for transistorized audio equipment plagued with audio rectification problems are contained in the diagrams of Figs. 2-a and 2-b from the FCC bulletin. A 250-pF capacitor or a low pass filter "pi" section consisting of two 250-pF capacitors and a series rf choke (I'd suggest about 5 to 7 µH if the interference frequency is between 30 and 110-MHz, and about 1.5 µH if the frequency is between 80 and 200-MHz—Editor) is inserted in the base circuit of the first transistor stage. In the case of stereo equipment, the modification would have to be made in each channel.

Suggestions from the EIA

The Electronic Industries Association bulletin delves more deeply into the subject of audio rectification and methods used to alleviate the problem. As they point out, circuitry unprotected

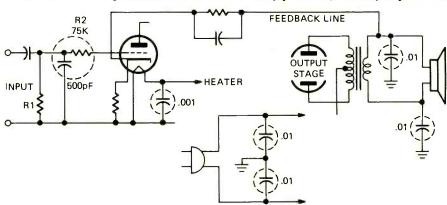


FIG. 1—FCC SUGGESTIONS of additional components to be added to tube amplifiers (circled components) to reduce interference from audio rectification of rf signals.

This timer produces an audible tick every second with the tenth tick emphasized. Construction A tick timer is a device which prois simple and it has many applications in photography

by FRANK H. TOOKER

NO MATTER WHAT OTHER TYPES OF timers a photography enthusiast may have in his darkroom, if he does any exposure manipulation of enlargements (dodging or printing-in), he needs a tick timer to get his best results.

duces an audible tick or click at precisely one-second intervals. It enables a darkroom worker to time the exposure intervals accurately without taking his eyes from what he is doing, thereby avoiding "spill-over" of the projected image into areas where it is undesired.

Do you like to go out on the streets with your camera and take pictures at night, as many of us do occasionally? If so, you know that night exposures can be a minute or more. Timing the exposures with a wrist watch and a small flashlight, while manipulating the camera shutter and at the same time keeping a wary eye open for the chance of an oncoming car with its bright headlights, can be almost too much at times. Take this accented tick timer along and let it do the exposure timing for you. It's battery operated and completely portable. Without fiddling with the wristwatch and flashlight to occupy and often frustrate you, you'll not only have a more enjoyable time, you'll probably end up with a batch of better pictures as well!

What's an accented tick timer?

The difficulty with the common tick

timer is identical to that of a dripping faucet — it's monotonus. Especially when you're working with a tricky exposure which requires concentration, it's easy to lose count, or to be in doubt as to whether the count is still accurate or not. And, of course, the longer the interval, the more likely it is that something like this will occur.

The timer described in the present article has been designed especially to overcome this difficulty. It provides accented ticks at regularly repeated intervals. Each 10th tick is made louder. So, if you've missed a tick, or think you have, your count can be corrected or assured at the conclusion of the 10-second interval. Furthermore, with an accented tick timer operating in the darkroom (if the count runs longer than 10 seconds (the usual case), it isn't necessary to count individual ticks until near the end of the count.

Suppose a particular exposure requires 35 seconds, for example. Keeping in mind that the louder ticks occur at 10-second intervals and the quieter ones at 1-second intervals, you simply begin the count and the exposure at the first louder tick. Count off the next 3 louder ticks (for the 30 seconds), then the next 5 quieter ticks for a total of 35 seconds.

How it works

The ticks of the electroric tick timer are current pulses made audible by a speaker. The unijunction transistor (UJT) is an excellent pulse generator. In fact, it's especially useful in this application because it synchronizes easily and because a UJT pulse-generator circuit is quite insensitive to variations in the powersupply potential. The accented tick timer operates from a 9-volt pattery, but even when the battery potential

PARTS LIST

All resistors 1/2 -watt 10% unless noted

R1-100,000 ohms, linear taper potentiometer

R2, R7-33,000 ohms

R3-100 ohms

R4, R8-300 ohms trimmer, linear taper

R5, R9-2,200 ohms

R6-100,000 ohms trimmer, linear taper

R10-220 ohms

C1, C4—10-μF, 12-volt electrolytic

C2-100-μF, 12-volt electrolytic

C3-0022-µF, 100-voit Mylar

Q1, Q3—2N2646 Unijunction Q2, Q4—2N697 silicon

B1-9-volt battery (see text)

S1—spst slide switch

ware and solder.

SPKR — 31/2-inch square intercom type speaker, 45-ohm V.C. (Quam 3AO7Z45) MISC-5 in. × 4 in. × 3 in. utility cabinet, screen wire for speaker grill, battery holder and connector, hard-

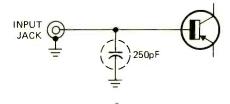
R6 100K 10/12V SPKR 100K CALIBRATE R10 ≸ ON-OFF .0022 220Ω 33K R2 Q2 33K 2N697 C 2N2646 2N697 2N2646 R3 100/12V R5 R9 **₹** R8 10/12V 300Ω 2N2646

FIG. 1—COMPLETE SCHEMATIC diagram. Circuit delivers a 1-Hz signal to the speaker with every tenth pulse accentuated.

Never Bargained For

have run across but weren't sure what was rectification. Its caused by rf signals being circuits. Here's an article on the causes and possible solutions.

from television and radio station interference is the main source of audio rectification. Interference can enter the affected unit by some portion of the equipment acting as an antenna and some other component acting as a detector. The form of interference may



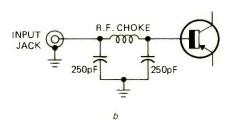


FIG. 2—SIMPLE BYPASS SCHEMES suggested by FCC for transistorized audio equipment.

range in frequency from as low as 50 kHz to as high as 1 GHz and may even include noise pulses from electric thermostats.

Determining the interference frequency

If interference is identified as audible voice or music over the speaker system. usually the offending AM station can be identified and its frequency thereby determined. If the interference is garbled and unintelligible (as was the case in our recording session) chances are it comes from a single-sideband (SSB) transmission—usually a local amateur radio operator. The frequency will usually be 3 MHz or higher. In the case of interference from FM transmissions, no actual sound will be heard but you may notice a decrease in volume of the desired program (records, tapes, etc.) whenever the interference takes place. Most FM transmissions (both amateur and commercial) are at a frequency above 30 MHz. Interference from a TV transmission is identifiable as a buzzing sound which changes its characteristics with time.

Isolating the problem

Most audio rectification occurs in

the audio detector or preamplifier section of a stereo component system or tape deck.

As a good first test, turn the master volume control down to its minimum position. If the interference is still present, the interference is occurring after the volume control, if not, it is being picked up ahead of the volume control.

RF interference ahead of the volume control

Some problem areas to consider are poor grounds, poor solder joints, electrolytic capacitors, long unshielded cables and the ac power lines themselves. Electrolytic capacitors that have been in use for several years may develop a high internal resistance. Paralleling a new capacitor across the suspected one is a good way to check this out. When multiple ground connections cannot be avoided in a system hook-up, interference due to resonance of loops formed by the shielded cables can be minimized by reducing contact resistance, shifting the position of the contact, or even changing lead lengths. Suspicious solder joints can often be the cause of audio rectification and should be carefully resoldered. Unshielded cables between components of a system or to extension speaker systems often act as excellent antennas for bringing the unwanted signal inside the chassis. Try replacing these with shielded cables.

If pickup is via the ac power lines, a line filter may solve the problem. One recommended circuit is shown in Fig. 3. Note that while 0.01-µf capacitors have been shown, these may or may not be safe for use across power lines, in terms of leakage current. Only components certified as being safe for use in power line wiring should be employed.

RF interference after the volume control

When the volume control is in its minimum position and the interference is still heard, some form of rf filter will be required in the audio amplifier itself. Shown in Fig. 4 is an example of the type of filter circuitry that has been proven effective in transistor audio circuitry. Values for the L, C and R components have been deliberately omitted because circuitry varies from product to product. The important

thing to remember is that these values should be selected so that there is no significant change in gain or frequency response. A small ferrite bead can often be substituted for L1 in the circuit of Fig. 4. Such beads, available in different inductance equivalent values, are simply threaded onto the bare wire leads of a component and act as finite inductances in the circuit. In the case

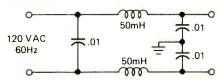


FIG. 3—POWERLINE RF FILTERING circuit suggested in new EIA bulletin on audio rectification.

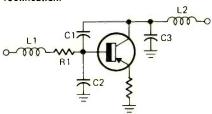


FIG. 4—SUGGESTED RF FILTERING CIR-CUITRY for use at input stage of audio equipment. Capacitors C1, C2, C3, series chokes L1 and L2 and series resistor R1 can be added separately or in combination.

of the diagram shown, the bead would be placed physically between the junction of C1-C2 and the base of the transistor shown.

All capacitors used in any of the circuits shown should be of the ceramic type, as these are better rf bypassing devices than paper types. Leads should be kept as short as possible and all ground connections should be soldered as close to the associated transistor stage as possible. It has been found that in areas of high rf energy, the inductor approach (used in a series connection) is more effective in blocking the transmission of such rf energy than is the shunt capacitor or series resistor approach.

Since interference may enter an amplifier via the output (especially in hifi amplifiers which invariably include a major feedback loop as part of the power amplifier design), speaker leads which are resonant to a particular frequency tend to aggravate the situation. For example, an 8-foot length of speaker cable will be resonant to incoming rf (continued on page 77)

SHORTER SEQUENCE LENGTHS					
STAGES	LENGTH	STAGES	LENGTH		
2	3	10	1023		
3	7	11	2047		
4	15	12	4095		
5	31	13	8191		
6	63	14	16,383		
7	127	15	32,767		
8	255	16	65,535		
9	511	17	131,071		

TABLE I-RANDOM SEQUENCE LENGTHS

					_	
				STATES FOR relength = 63)	1-6	
000000	(0)	011100	(28)	000111	(7)	001000 (8)
100000	(32)	101110	(46)	100011	(35)	100100 (36)
110000	(48)	010111	(23)	110001	(49)	110010 (50)
111000	(56)	101011	(43)	011000	(24)	011001 (25)
111100	(60):	110101	(53)	101100	(44)	001100 (12)
111110	(62)	011010	(26)	110110	(54)	100110 (38)
011111	(31)	001101	(13)	011011	(27)	010011 (19)
101111	(47)	000110	(6)	101101	(45)	101001 (41)
110111	(55)	000011	(3)	010110	(22)	010100 (20)
111011	(59)	100001	(33)	001011	(11)	101010 (42)
111101	(61)	010000	(16)	100101	(37)	010101 (21)
011110	(30)	101000	(40)	010010	(18)	001010 (10)
001111	(15)	110100	(52)	001001	(9)	000101 (5)
100111	(39)	111010	(58)	000100	(4)	000010 (2)
110011	(51)	011101	(29)	100010	(34)	000001 (1)
111001	(57)	001110	(14)	010001	(17)	(000000) ((0))

TABLE II—THE SEQUENTIAL STATES for the circuit n=6 in Fig. 1. The first (input) register stage is on the left, the last (output) on the right. Numbers in parentheses are the decimal equivalents of the binary words.

STAGES	SEQUENCE LENGTH	FEED EXCLUSIVE-NOR GATE FROM OUTPUTS		
17	131,071	14 and 17		
18	262,143	11 and 18		
20	1,048,575	17 and 20		
21	2,097,151	19 and 21		
22	4,194,303	21 and 22		
23	8,388,607	18 and 23		
24	16,766,977	19 and 24		
25	33,554,431	22 and 25		
26	67,074,001	21 and 26		
27	133,693,177	19 and 27		
28	268,435,455	25 and 28		
29	536,870,911	27 and 29		
30	1,073,215,489	23 and 30		
31	2,147,483,647	28 and 31		

TABLE III—HOW TO CONNECT FOR SEQUENCES UP TO 31

in a proper circuit to generate a *new* one or zero in unique response to the state the register is *now* in.

The logic for maximal length takes nothing but exclusive NOR gates and turns out to be unique. Any logical combination of outputs to drive the input will give us some sequence length. The problem with the majority of connections is that they only generate a very short (or maybe only a 1-bit!) sequence, and that the states going through the register do not have the random-looking properties that we need.

What we have to do is find the magic combination of logic and feedback that will generate the maximal length sequence for a given stage length. To do this takes a bunch of high-level math, but it has to be done only once. Circuits that will do that are shown in Fig. 1 for register lengths of 2 through 16.

Some more details

Let's actually build a real 63-bit sequence circuit. It's shown in Fig. 2. We use the first six stages of a 74164, one-half of a 7486 quad EXCLUSIVE-OR gate with the two sections cascaded to form an EXCLUSIVE-NOR, the usual 5-volt supply and decoupling, and a variable-speed clock made up from a MC1555 or 555 timer.

Every time the circuit is clocked, it advances one count and generates a pseudo-random sequence of 63 of its 64 possible states. The clock frequency determines how fast the states will change,

while the sequence time will be 1/63rd the clock frequency if you run the circuit continuously. We can use the serial bit stream or we can use the digital words that show up in parallel on the register outputs. Or, as we'll shortly see, these are easy to convert to analog "noise" or discrete, randomly varying analog levels.

The two cascaded EXCLUSIVE-OR circuits form an EXCLUSIVE-NOR or comparator. If both inputs are the same, a "1" is output. If the inputs are different, a "0" is output. Thus our feedback circuit looks at stage 5 and stage 6 to see what they were before the new clock arrives. The output of the EXCLUSIVE-NOR then sets up what stage 1 is to be after clocking, determined by whether the logic levels on stage 5 and 6 are the same or different.

For instance, in the 63-word sequence of Fig. 1 (n=6), if 5 and 6 are both 0's, a "1" gets entered into the first s age on the next clocking. What was in the first stage goes to the second; the second to the third, and so on. If 5 is a 1 and 6 is a 0, a "0" goes to stage 1 on the next clocking. The same thing happens if 5 is a 0 and 6 is a 1. Finally, if 4 and 6 are both 1's, a 1 is sent to the first stage on the next clocking.

In this manner, the entire pseudorandom sequence is built up. To see how beautifully it works, set up a table like that of Table II for some of the shorter sequences of Fig. 1—say the 5-word sequence of n-3.

All 63 states are shown in Table II. As you can see, any short-term group of bits in the middle jumps around in a very nearly random manner: If you count the number of sequential 1's and 0's you get and work up a distribution curve, it turns out to be a rather chunky approximation to a random probability curve. As we add more and more register stages, the curve smooths out, and the more stages, the better the randomness. For any circuit, the maximum number of sequential I's or 0's we can get has to be equal to or less than the register length. Opviously we get far more short bursts cut than long ones. If you go through all the statistical math, you find that you do have very nearly a truly random behavior on a short-term basis, only one that nicely repeats every time we ask it to. In fact, things turn out even better than random noise, since you get the andomness over one sequence length while "true" noise would theoretically take forever to be truly random. Longer sequences behave even better.

Available sequences

There are usually at least four possible maximal length sequences for any stage length. Circuits to get all jour are shown in Fig. 3. If we take the circuit we have and invert the input, we get an inverted sequence in which all he ones are zeros and vice versa. Or, instead of looking at what's going to happen next, we can look to see what already did happen and get a backwards sequence. Finally, we can both look backwards and invert to get a backwards sequence with interchanged ones and zeros. All four circuits have essentially the same random-



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POCKET RADIO

SIGNAL GENERATOR ness properties. Which one you use depends on how you like to start the circuit and what output polarity you want. In electronic music, it's handy to use all four, for you can get a sequence, the sequence played backwards, or the sequence played on an inverted scale or on an inverted scale and backwards.

The disallowed state

One little detail we have to watch for is the unused state. If you ever get into the 111111 state with the normal circuit, it will stay there forever! The backwards version will also stick in 111111. while either inverted (complementary) sequence sticks in 000000. So, we must never allow this state to occur. It's easy to reset or preset our register or otherwise make sure we also start our sequence on a known valid portion of the sequence. By the way, this is true of almost all counters and sequential circuits in general. You have to investigate all the disallowed or "don't care" states to make sure none of them are self-perpetuating.

One other little detail is that we obviously must get an additional 1 or 0 (or one less zero or one) since our code

is always an odd number of bits long. This missing 1 or 0 will tend to skew the random distribution slightly and will tend to shift the bias on an analog conversion scheme slightly. This is easily avoided by compensating bias resistors, and the longer sequences have almost negligible skew and randomness bias.

Converting to analog

Figure 4 shows two different ways to convert the digits to numbers. In 4-a, we use an integrator or low-pass filter on the serial bit stream, and the output of the integrator is an analog voltage that varies in a random manner. The short-term output is noise that behaves just like white noise up to the filter's cutoff frequency or at least up to a good fraction of it. A cutoff frequency of 1/20 the clock frequency is recommended, particularly for longer sequences. A different possibility is shown in Fig. 4-b.

Here we directly D/A convert the parallel digital words to an analog signal. With this circuit, you get analog levels that jump to some new random value, once every clock cycle.

To find the time the sequence repeats,

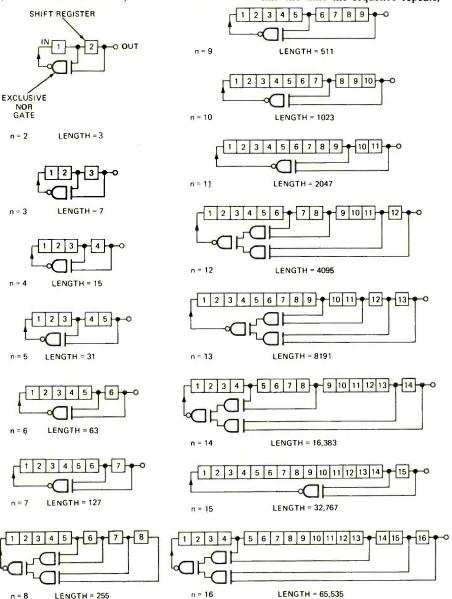


FIG. 1—PSEUDO-RANDOM CIRCUITS that produce sequences from 3 to 65,535 words.

just divide the clock frequency by the sequence, the repeat time will be 100,using a 100-kHz clock and a length 16 sequence, the repeat time will be 100,-000/65,535 or about 1.5 times per second. If you are using the 63-note sequence for electronic music at 3 notes per second, it repeats once every 21 seconds. A 127-note sequence would be good for 42 seconds, and so on. As an extreme example, if you used a 48-stage MECL shift register and a 100-MHz clock, it would take around 3 million seconds or over half a year to repeat. At lower clock frequencies, it would take decades or even centuries!

The serial conversion circuit of Fig. 4-a works best when the clock is at least 20 times the filter's cutoff frequency as determined by the capacitor values. Thus, for high-quality audio testing and requirements of this type, you use as long a register length and as fast a clock as you can.

Applications

Let's briefy turn to the things you can do with a pseudo-random sequence generator.

For audio testing and communications, you normally use a very fast clock and a sequence that repeats perhaps 30 times a second, so you can get a stable oscilloscope display. The filtering then gives you random signal variations that duplicate the effect of random combinations of voice or communications data or signal levels. Commercial instruments are available (Hewlett-Packard, among others) that do just this. The net result of the testing is that you simulate the real operating conditions in a realistic man-

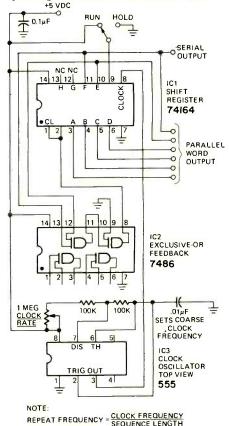


FIG. 2—THIS LENGTH-63 CIRCUIT uses 6 stages (n=6).

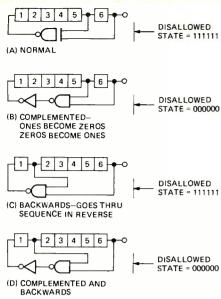
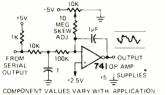
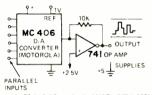


FIG. 3 - FOUR POSSIBLE SEQUENCES for any n can be made by rearranging the circuit.



COMPONENT VALUES VARY WITH APPLICATION
(A) USING SERIAL OUTPUT TO GET ANALOG PSEUDO NOISE



VALUES AND CONNECTIONS VARY WITH APPLICATION
(B) USING PARALLEL OUTPUTS TO GET RANDOM OUTPUT LEVELS

FIG. 4-ANALOG OUTPUT CIRCUITS.

ner but also in a way that lets you see the results as a stable display.

Electronic music uses are relatively obvious. By interchanging the outputs in a programmable manner, you can use one basic sequence generator to build a fantastic number of tunes and can obtain them frontwards, backwards, normal scale or inverted. Some of these combinations will be dull and others will be simply phase-shifted replicas of others, but the number of unique and interesting variations remaining are still a bunch. Figure 5 shows one possible electronic music composer. By adding random rhythm and pause combinations, you can end up with an essentially infinite number of variations. You can also use pseudorandom sequences to generate timbre waveforms for electronic music.

Secure computer communications encode the data to be transmitted onto a pseudo-random sequence that is locked to a replica at the far end. Usually, the sequence length is very long, days, months, even years. Cryptography and other security schemes are other applications of this type. As with any code, regardless of its complexity, it can be broken. The object of any code game is to make cracking the code so complex,

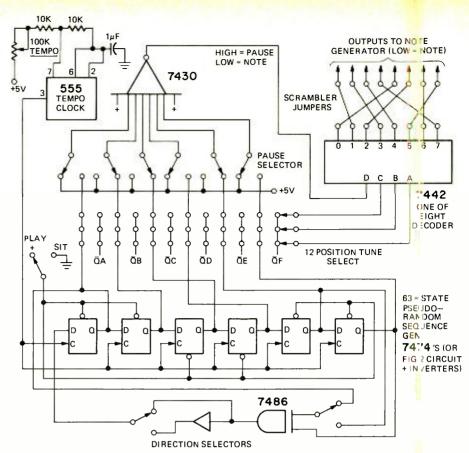


FIG. 5-POSSIBLE MUSIC COMPOSER.

make it take so long, or make it so expensive that the cost of cracking exceeds or at least severely diminishes the value of the information to be gained. So, as with all codes, the pseudo-random technique is a reasonably effective deterrent, not a fail-safe and foolproof route to security.

To encode or decode data, two EX-CLUSIVE-NOR gates are used, one at each end of our secure line. Remember that the output of an EXCLUSIVE-NOR is the same if the inputs are identical and different if they differ. So, if our pseudorandom generator happens to be in a "1" state, input data 1's stay ones and 0's stay zeros, e.g. they are transmitted with-out "error." On the other hand, if our pseudo-random generator happens to be in a "0" state, the 0's become 1's and 1's become 0's; we say the data is complemented. Since the line now consists of a random mixture of good and bad data, it appears to be garbage to anyone monitoring in the middle. At the other end, we simply add a new pseudo-random generator identical in length and sequence to the original; once again, it inverts when zero and passes when one; and all the data straightens back out again. Figure 6 shows the circuit.

Autocorrelation is a very complex subject, but it dramatically illustrates the power of pseudo-random sequences. Suppose we have a sequence length of 63 and that a 1 is +1 volt and 0 is -1 volt. If we multiply the code by itself on a bit-by-bit basis, we would get +63 volts out. On the other hand, if we multiply the code by a delayed replica of itself or a random string of ones and zeros, we will probably get a very low value,

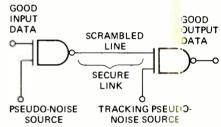


FIG. 6-A PSEUDO-RANDOM CODEFI or data scrambler for privacy or cryptography.

maybe +1 or -1 out. Thus when the code matches itself, you get a very strong output signal; otherwise you get very little. Only the Barker codes can give you perfect + and -1 sidelobe levels; the mismatch and noise level produced in a pseudo-random code is higher, but still has a very useful sidelobe level.

This tremendous build-up of signal buys you a signal-to-noise imprevement and the ability to extract a signal deeply buried in uncontrollable noise.

Longer sequences

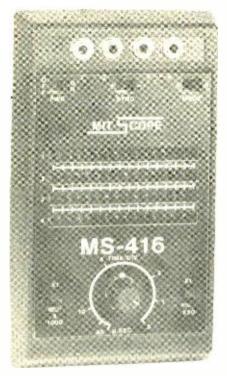
The schematics for sequences longer than 16 get rather cumbersome to draw, so they are shown in table form in Table III. The lengths are shown up to 31 stages, which is a sequence length of 2,147,483,647. That should te long enough for just about anything. Note that this sequence can be built up with only four of the 74164 shift registers. Sequence 19 is omitted because it takes more than one exclusive OR sate to build it. There are likewise other possible maximally long or nearly maximal sequences for lengths 17, 21, 22, 23, 25, 27, 28, 29 and 31, but one should be enough for each length. R-E

49

INAKIT

4-Channel Storage

> Using LED indicators, this has full storage triggering. The LED matrix with 16



THE MS-416 has a time-base range of .5 μs to 200 ms that will cover most digital circuit needs.

WITH THE RAPID INCREASE IN INTEGRATED circuit technology, more and more electronic equipment is being designed around digital circuitry. These new circuits are full of complex timing sequences and elusive pulses. Elusive because the pulses occur one-time and one-time only.

There are many three- and four-channel oscilloscopes on the market which can handle complex timing relationships. But they are generally very expensive, cumbersome instruments and are usually found only in very well-equipped labs.

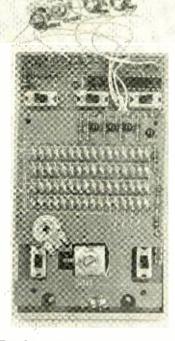
Another instrument sometimes used in testing digital circuitry is the logic probe. Many logic probes have built-in pulse catchers for those one-time pulses. However, they are inadequate for most circuit testing and nearly useless in complex timing situations.

As a result, a new instrument has been developed. It is called the MS-416, and it incorporates the best features of both the oscilloscope and the logic probe.

The MS-416 is an inexpensive, four channel, hand-held, digital logic oriented scope with full memory capability. The time-base range from .5 μ s to 200ms will cover most digital circuit needs. With four channels, extensive timing relationships can be easily observed. Signals are displayed on a 4 \times 16 LED matrix; 4 channels, with 16 LED's per channel.

In addition to the normal mode of operation, the MS-416 can be switched into storage operation at any time during

The MS-416 is available in kit form for \$127.50, or assembled for \$189.50, from MITS, Inc., 6328 Linn, N.E., P.O. Box 8636, Albuquerque, NM 87108.



INTERIOR VIEW of the MS-416. Calibration of the unit is a simple one setting operation.

testing and will "remember" the information present on all four channels of its display. It will hold this information until it is switched back to normal operation or turned off. The storage mode also serves as an excellent pulse catcher for those elusive one-time pulses. The MS-416 will wait until the pulse occurs and then hold it in its memory as long as it is desired.

Together with positive- or negativeedge triggering, an auto-sweep mode for steady-state logic measurements and a Ni-Cad battery supply, the MS-416 becomes quite a versatile piece of equipment.

Circuit operation

The MS-416 consists basically of eight interconnecting circuits. The block diagram in Fig. 1 shows a power supply, a memory, a clock oscillator, a counter, a decoder, a mode select circuit, a sync circuit and a display.

The complete schematic of the MS-416 is shown in Fig. 2. The power supply will run on 117 Vac with an ac adapter. Using the adapter (a standard 9V unit), the supply is regulated by D1, a 5.1 V Zener diode. C1 provides filtering, and a separate filtering network (R6 and C2) is used for the clock oscillator IC-g. When the power switch S1 is in the OFF position, the adapter is used to charge the Ni-Cads through R1 and R2. To run on Ni-Cads, simply unplug the adapter, which shorts the A and C contacts of the ac jack, and switches the unit on, In battery operation, the supply is essentially unregulated to eliminate unnecessary current drain. It takes approximately 14 hours to charge the batteries, and with a full charge they will power the unit for about 1½ hours of continuous use.

The memory consists of a 64-bit RAM (Random Access Memory), Am31L01 (IC-a). The signal inputs are buffered through IC-b and the inverted signal is fed directly into the four word bit inputs of the RAM. Each word consists of 4 bits, one bit for each channel.

The 4 bit word is selected by the binary outputs of the counter (IC-c) connected to the four address inputs of the RAM. The RAM is addressed simultaneously with the 4×16 decoder (ICf). As the 16 words are addressed one at a time, the signal present at each of the 4 inputs is written into the memory and fed, inverted, to the RAM outputs. The chip-enable input of the RAM is pulsed high at the end of each 16 count, disabling the memory while the counter resets. This will cycle continuously as long as the unit is in the normal operation mode, and the mode select circuit holds the RAM in the Write mode. In the storage mode, the mode select circuit switches the read/write input of the RAM to Read after one full 16 count. The signals present on the RAM inputs will then be continuously displayed as long as the unit is in the store mode.

The clock oscillator uses four inverter gates of IC-g, along with two variable resistors (R4 and R5), and two capacitors (C3 and C4) to produce the variable frequency signal used for the timebase. Switch S4 selects either a 620-pF capacitor (C3) for the X1 range or a $.68\mu f$ capacitor (C4) for the X1000 range as part of the time constant for the oscillator, A 50-ohm trim pot R5 is used for calibration, and a 5K ohm linear taper pot is used to vary the time constant to select the initial sweep rate for the time-base, Switch S5 either sends the clock signal to IC-e in the X1 position or, in the X20 position, sends it through IC-j for a divide by 10 and IC-h for a divide by 2 before sending it to IC-e. Using S4, S5 and R4 you can produce a time-base from $0.5-\mu s$. to 200 ms. The final signal is fed through a NAND

Digital Scope

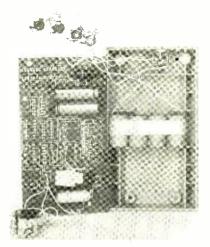
4-channel digital scope capability and automatic readout is a 4 X 16 LED's per channel.

by JAMES B. VICE

gate and an inverter gate to the counter. The counter is a 7493 4-bit binary counter (IC-c) operated in the ripplethrough configuration (series of flip flops), providing simultaneous divisions of 2, 4, 8 and 16 of the clock frequency on its four outputs. The outputs are fed to both the 4 \times 16 decoder and the RAM address inputs, keeping the two synchronized. The divide by 16 output, pin 11, is also fed to the clock inputs of the flip-flops (IC-d) in the sync and mode select circuits. As the 7493 counts up. the d output goes high on the 9 count and falls after the 16 count. This falling edge is used to toggle the flip-flops.

The decoder is an Am93L11 4-line to 16-line decoder/demultiplexer. As the counter feeds information into the decoder's four binary coded inputs, its outputs 0 through 15 are strobed low sequentially at the rate determined by the clock oscillator frequency. These outputs are fed through transistors to the display. The decoder is disabled at the end of each 16 count by the same signal that resets the counter.

The mode select circuit consists of switch S3 and one flip-flop of IC-d. In



INTERIOR VIEW of the MS-416. The main circuit board is swung away to show the underside of the main board and the batteries.

the normal mode of operation, the clear input of the flip-flop is held low by S3 to ground, keeping the flip-flop in the clear state. This prevents the clock input of the flip-flop, which is connected to the D output of the counter, from having any effect while in the normal mode. When S3 is switched to store, the clear input goes high so that when the signal on the counter D output falls after the 16 count, the flip-flop will toggle. The flip-flop is connected so that it latches. and it will stay latched until S3 is returned to the normal position. When the flip-flop latches, the Q output goes high, switching the RAM to the Read mode. Simultaneously, the Q output goes low and is used to block the signals on the input buffer (IC-b) and to block pulses from the sync circuit at pin 10 of IC-e. When S3 is switched back to normal the flip-flop immediately goes back to its clear state.

The sync circuit is both the most complex and the most important circuitry in the unit. It consists of a 9601 retriggerable one-shot (IC-k), four NAND gates of IC-e, two inverter gates of IC-g and one flip-flop of IC-d. The signal for the



INTERIOR VIEW of the MS-416. The display board is swung away to reveal the main printed circuit board.

sync is taken from the output of the channel one buffer (pin 3 IC-b). The sync signal is fed to S2 and one gate of IC-e which is connected as an inverter. The input to the one-shot is taken from S2. In this manner, switch S2 is used to select either the rising edge or alling edge of the input signal for synchronizing the MS-416.

The one-shot has an output pulse duration of approximately 160 ns. The Q output of the one-shot is fed into pin 5 of one NAND gate of IC-e where it is gated together with the Q output of one flip-flop of IC-d.

This gate is used to prevent any one-shot pulses from passing while the counter is counting up. The output of the NAND gate is again fed into one input of another NAND gate where it is gated together with the Q output of the mode select flip-flop. The output of this gate goes through an inverter gate of IC-g and to the clear input of the sync flip-flop. The clock input of the sync flip-flop is connected to the D output of the counter; therefore, when the signal on the counter falls after the 16 count, the flip-flop toggles.

This causes several things to happen at once. The O output of the flip-flop is connected to another NAND gate of IC-e, together with the clock signal, and then through another inverter to the counter. The NAND gate serves to block the clock pulses from reaching the counter while it is being reset. The Q autput of the flip-flop is used to resut the counter, disable the decoder and disable the RAM. It is also used to set conditions at pin 4 of IC-e to allow the next one-shot pulse to pass. When the next one-shot pulse occurs, it will pass through to clear the sync flip-flop, starting the entire sequence over again.

The display consists of 64 RL-50 LED's arranged in a 4 × 16 matrix; along with associated driving circuitry (Q1 through Q20 and resistors R8 through R15). Transistors Q17 to Q20

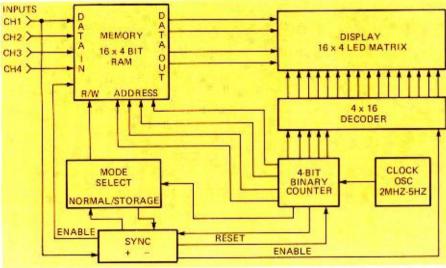


FIG. 1—MS-416 BLOCK DIAGRAM. The trigger circuits are synchronized to the channel-1 signal.

(CS4410's) are switched on and off with the information from the RAM outputs. Transistors Q1 to Q16 (EN2907's) are pulsed low at their bases one at a time by the decoder outputs, providing a path to ground for the LEDs. Each output word from the RAM consists of four bits, each bit corresponds to one channel, and each of the decoder outputs corresponds to one RAM address. The RAM address and the decoder output are changed at whatever rate is predetermined by the clock oscillator frequency. As an example; if the counter is at its 2nd count, the RAM will be at its 2nd address and Q2 will be turned on. If there is a positive signal on the RAM output to Q18 at this time, then LED D23 will light for however long the clock frequency determines.

There is also an auto-sweep circuit for measuring high or low steady-state conditions. Since the sync circuit requires a pulse to function, a steady-state condition has no effect and is never seen. Switch S6 allows the unit to measure these signals by switching the clock oscillator signal into the other A input of the one-shot. This allows the sync to be continuously triggered. When not in auto-sweep operation, S6 holds the input to the one-shot at $V_{\rm cc}$.

How's it's made

The MS-416 is built around two double sided PC boards with plated-through holes. As the unit is quite compact, the builder must be sure that all components are installed as close as possible to the boards and all excess component leads

and IC pins are cut off as short as possible without damaging the connection. The boards are assembled one at a time and then wired together after all the components have been installed on the component side of the boards. (There are five components mounted on the opposite side. These will be mentioned later).

The first step in construction is to install switches S1 to S5 on the main board. These are the only components on the boards that are not installed flat against the boards.

The next step is to install the integrated circuits. Orient them correctly according to the component layout, and be sure to push them down as flat against the board as possible.

At this point it is best to install the

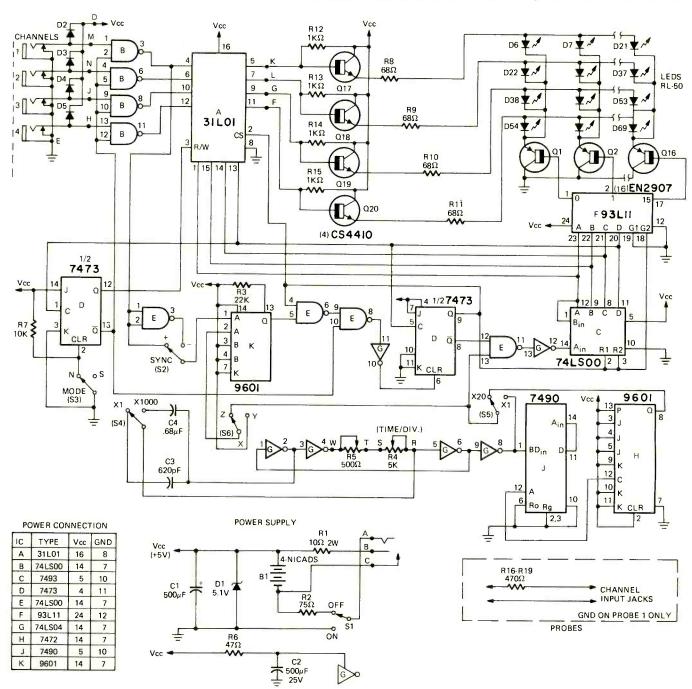


FIG. 2—COMPLETE SCHEMATIC DIAGRAM of the MS-416. Power can be supplied with an optional 117-Vac adapter.

components that go on the back side of the board (R1 and capacitors C1 through C4). Be sure that the polarity on C1 and C2 are correct.

Install Zener diode D1, and make sure polarity is right.

Resistors R2, R3, R6 and R7 are installed next and then transistors Q1 through Q16. Be sure the base-emitter-collector leads of the transistors are properly aligned. This finishes the main board for the time being.

Assemble the LED board in the following manner. Resistors R8 through R15 and transistors Q17 through Q20 are installed on the LED board in the same manner as those on the main board.

The next step requires the greatest care and takes the most amount of time. LED's D6 through D69 are installed. Be sure to align them in straight rows and columns. It is helpful when doing this to draw lines on the PC board with a ballpoint pen and follow these lines while installing the LED's.

The 500-ohm trim pot, R5, is now installed after bending its three leads downward. Insulate the body of the pot from any copper foil on the board by placing a small piece of tape placed directly underneath it. This finishes assembly on the LED board.

Wire the 5K potentiometer, R4, to the main board. Switch S6, located on the pot is also wired to its respective pads on the board. Insert these wires from the back of the board and solder them on the component side.

The two boards can now be wired together. The pads to be connected are marked the same on both boards to make wiring easier.

Finally, the case top and case bottom are assembled. The four input jacks and diodes D2 through D5, along with the

front panel fasten to the case top. It is best to wire the jacks before installing them in the case. The Ni-Cads and the ac jack are installed in the case bottom. Be sure battery polarity is correct. Wire the components in the top and bottom cases to the rest of the circuitry, and you are ready to calibrate the unit.

Calibration is easy

Calibrating the MS-416 is a simple, one-setting operation. In this method, a frequency meter or oscilloscope is needed; although instructions are included with the kit that show how you can set it up without special test equipment, but are less accurate.

For the most accurate calibration, switch S4 should be in the X1000 position and S5 in the X1 position. The TIME/DIV pot R4 should be set in its fully clockwise position. Connect your test instrument ground to the ground on the ac jack and your test probe to the switch terminal on R4 which connects with pad Z on the main board. Connect the unit to the ac adapter and turn the power switch to ON.

Adjust trim pot R5 until the clock oscillator frequency reads exactly 2kHz. Once this frequency is set, the unit requires no further calibration.

The unit can now be completely assembled using the hardware supplied with the kit, and the knob installed on R4. This is done by turning R4 fully clockwise and aligning the pointer on the knob with the $.5\mu$ s marking of the TIME/DIV scale on the front panel.

Using the MS-416

Although the inputs to the MS-416 are protected against overload, remember this is a digital logic oriented instrument; therefore, you should not measure sig-

nals which exceed digital logic voltage levels. In most digital logic, the maximum voltage for a logic "O" is 0.8 voit, the minimum voltage for a logic "1" is 2 volts. The maximum input voltage from the unit you are testing should not exceed 5.5 volts.

When measuring a signal, keep in mind that the sync operates from the channel one input and therefore this channel must be used if you are using less than all four channels. It is best to attach the probe with the ground lead to the channel one jack as a reminder. (Four probes are also supplied with the kit.)

The display of the MS-416 is interpreted in much the same manner as a conventional oscilloscope. The settings on R4 and switches S4 and S5 determine the TIME/DIVISION of the sweep, and each of the 16 LED's in each channel represent one division. Synchronizing from channel one, the signals are displayed showing the logic levels ("1"=LED on. "0"=LED off) and their respective timing relationship.

Turning the TIME/DIV knob fully counter-clockwise to AS (auto-sweep) illows the measurement of steady-state conditions by lighting the entire channel for a logic "1", or blanking the entire channel for a logic "0".

For storage operation simply witch the mode switch to "S" at any time, and the next sweep will store any information present.

If you wish to catch that elusive onetime pulse, simply place the unit in the proper conditions for usual storage operation, setting the mode switch to "S" before you place your probe on the test point you wish to measure. As soon as a pulse comes along it will be "caught" in the memory and held there as long for as

Portable record player introduces new ideas

A new portable two-speed record player operates without the need for the conventional on-off switch, and uses



a hither-to-unknown method of changing speeds. The player simply puts on the record and turns the spindle in a

clockwise direction to start the machine.

The new automatic speed changer operates around a "Magic Ring," a one-piece component made of Celcon (Celanese) plastic, which surrounds a spindle shaft centered within a shallow cupped base. This part acts as a weight sensor, and selects a speed of either 33½ or 45 rpm according to the weight of the record.

The center post of the "Magic Ring" is also the off-on switch. Turning it clockwise starts the machine. It is also the shaft of the volume control, and continuing to turn it brings up the volume.

Inventor and designer of the new-idea player is Art Tateishi, president of Seabreeze Products of Canada, a Toronto company which makes the unique player.

Industrial Research Institute honors zone-melting inventor

W. G. Pfann, who invented the zone melting technique for producing the high-purity metals that make modern transistors and integrated circuits possible, has been awarded the second Annual Achievement Award of the Industrial Research Institute.

The Bell Labs was given a sculpture symbolizing creativity in industrial research,

and was cited for "his vision and leacership in recognizing the requirements for ultrahigh purity materials. This foresight resulted in his research on zone melting and refining and crystal growth techniques.



W. G. PFANN, BELL LABS SCIENTISI, center, receives the award, a sculpturec work of art, entitled "Man and Technology.' from Dr. N. Bruce Hannay, I.R.I. president, right. The presentation address was given by Dr. William P. Slichter, at left in the photo.

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Understanding today's audio technology requires practical experience with high caliber equipment. And with the Bell & Howell amplifier and tuner, you've got the technological tools you need to gain the knowledge and skills that could open up opportunities for



you in the audio field. Of course, we cannot offer assurance of income opportunities.

The sophisticated amplifier gives you the circuitry you need to conduct the comprehensive experiments necessary to master audio technology. Like signal tracing low level circuits, trouble-shooting high power amplifier stages, and checking the operation of tone control circuits.

You'll investigate the technology behind this amplifier's full logic, 4-channel decoder and learn how full logic decoding produces outstanding front to back separation.

The tuner you build has both superior performance specs and state-of-the-art features such as: all solid state, FET front end for superior sensitivity, crystal IF filters for wide bandwidth, and a superior stereo multiplex circuit for excellent stereo separation.

You cover the full range of electronic fundamentals.

But make no mistake. This learn-at-home program is not just about 4-channel sound. It covers the full range of electronic fundamentals leading to understanding audio technology. So when you finish, you'll have the occu-

technology. So when you finish, you'll have the occupational skills to become a full-service technician, with the ability to work on the full range of audio equipment such as tape recorders, cassette players, FM antennas, and commercial sound systems. Get complete information on this unique program by checking the appropriate box on the card—mail it today!

†Cabinets and speakers available at extra cost.



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about curve tracers

This article tells what to look for when purchasing a curve tracer; how to test different solid-state devices, and how to interpret the resulting waveforms

by CHARLES GILMORE*

LAST MONTH WE COVERED THE FUNDAmentals of curve tracers and started discussing the testing of diodes.

This month we will complete testing and look into testing of bipolar and field-effect transistors.

The curve tracer can examine curves of the reverse-biased diode as well as the forward biased diode. When the diode is reverse biased, theoretically no current flows. However, as shown in Fig. 6, there is current flow once the reverse breakdown voltage of the diode is reached. When the unknown diode is being used as a replacement part in a circuit, the reverse breakdown voltage

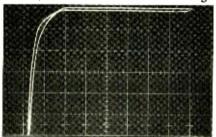


FIG. 6—THE REVERSE CHARACTERISTICS of the 1N4149 silicon small-signal diode. Settings are: cathode series limiting resistance, 10,000 ohms; horizontal sensitivity, 20 volts/cm; vertical sensitivity, 0.5 mA/cm. Note that some looping is caused by internal heating of the diode during sweep and by stray capacitances.

should be measured. Once the diode's reverse breakdown voltage has been determined, the circuit parameters will tell you if it can be used as a replacement part. Some diodes tend to show a fairly large reverse current before they reach reverse breakdown. This leakage current can make the diode an unsuitable replacement. Generally, with small signal diodes the leakage currents are so small that they are unnoticeable on most curve tracers.

The Zener diode is simply a diode whose reverse breakdown characteristics are known and controlled. Figure 7 shows the characteristics of a 1N750 Zener diode. Poor regulation in a Zener-regulated circuit can be caused by too high dynamic resistance when the Zener is conducting. The dynamic resistance of the Zener diode can be computed in

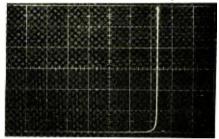


FIG. 7—THE REVERSE CHARACTERISTICS of the 1N709A silicon Zener diode. The diode is rated at 6.2 volts ± 5% at a Zener current of 25 mA. The curve tracer settings are: cathode series limiting resistance, 5000 ohms; horizontal sensitivity, 1 volt/cm; vertical sensitivity, 5 mA/cm. Note that the Zener curve passes through 6.4 volts at the horizontal line representing 25 mA.

exactly the same manner as the forward dynamic resistance of a diode. By referring to the manufacturer's data on the Zener diode, we can learn at what current the Zener voltage is specified and over what current ranges the dynamic impedance of the Zener is specified. When measurements are made "in circuit," the dynamic resistance of the diode is increased by the resistance of other circuit elements in series with the measurement.

The curve tracer is ideal for determining tunnel diode characteristics. As shown in Fig. 8, the characteristics of the tunnel diode are quite unique and you can readily identify the device by them. When using the tunnel diode, the limiting resistor may have to be adjusted to prevent oscillation. Tunnel diodes have a negative resistance region, where the current decreases as the voltage increases. Given the prop-

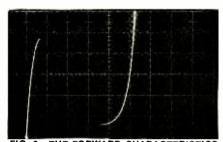


FIG. 8—THE FORWARD CHARACTERISTICS of a GE TD-716 tunnel diode. Settings are: anode series limiting resistance, 5000 ohms; horizontal sensitivity, 0.1 volt/cm; vertical sensitivity, 1 mA/cm. Note the area of trace between the peak current and the valley current is almost impossible to see. If this area of the display contains scrolls, read just the value of series limiting resistance and the sweep voltage to get a trace without scrolling.

er conditions, the negative resistance sustains oscillation.

When the display has been properly adjusted and there is no oscillation (identified by looping or scrolls on the trace), some of the frequently specified characteristics on a tunnel diode can be readily measured. These are: the peak voltage at the start of the tunneling region (V_p); the valley voltage at the end of the tunneling region (V_v); the peak current at the start of the tunneling region (I_p) ; and the valley current at the end of the current tunneling region (I_v). Once these parameters are known, the average value of negative resistance can be computed as $(V_v - V_p)$ divided by $(I_p -$ I_v). When tunnel diodes are displayed on the curve tracer, the region between the peak and valley voltages, that is, the region of negative resistance, is frequently quite dim.

The diac or trigger diode, that is frequently used in series with the gate of a Triac or SCR to fire the device, has the characteristic curve shown in

^{*}Design Engineer Heath Company, Benton Harbor, Mich.

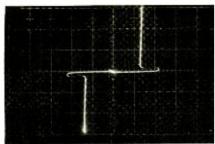


FIG. 9 — THE FORWARD AND REVERSE CHARACTERISTICS of a diac or trigger diode. A double exposure shows both forward and reverse curves in one photograph. Curve tracer settings for reverse measurements are the same as for the forward measurements except the polarity of measurement has been reversed. The curve tracer settings are: series limiting resistance, 5000 ohms; horizontal sensitivity, 20 volts/cm; vertical sensitivity 2.0 mA/cm. Note the match between the forward and reverse breakover voltages.

Fig. 9. Two curves are shown for the diac, a bi-directional device, as the diac has similar characteristics in the forward bias and reverse bias directions. The forward blocking voltage indicated on the display is that voltage where the horizontal line stops and a fine trace swings back to the high current point, showing low forward voltage drop. As the sweep voltage is decreased, the current through the diac is reduced until it finally stops abruptly. This point gives a measurement of the holding current.

2. The bipolar transistor — A large number of characteristics of npn and pnp transistors can be measured with a curve tracer. All measurements applicable to npn devices also apply to pnp devices. The only difference is in the initial set-up. To measure npn devices, the collector or sweep voltage must be positive, and often this is shown on the curve tracer as the npn position. The base or stepping generator must also be in the positive current or npn position. (Note that at this time we use a current generator, as a transistor is a current-operated device). Transistors can be easily damaged if the voltage output of the stepping generator is used.

If an unknown device is found and a curve tracer is used to checkout the characteristics of the device, including pnp or npn, the beam may be initially placed in the center of the curve tracer display. Very moderate levels of sweep voltage and step current are applied first, with a midrange setting of the steps per family control, in the npn direction and then in the pnp direction. One test will yield a family of curves, the other a straight line. The test yielding the family of curves identifies the device. Be sure to keep both the base current and the collector sweep voltage well within the reverse breakdown ratings of the transistor. If incorrect settings are used

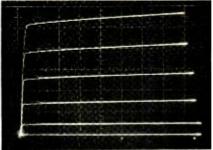


FIG. 10—A FAMILY OF SIX CURVES generated by a 2N3393 silicon npn general-purpose small-signal transistor. Settings are: step generator, 0.01 mA/step; collector series limiting resistance, 100 ohms; horizontal sensitivity, 2 volts/cm; vertical sensitivity, 1 mA/cm. At a collector voltage of 8 volts, the current change indicated by curves three and four is 1.3 mA. As this was caused by a step of 0.01 mA of base current, the beta of this device at this particular operatinig point is 1.3/0.01 = 130.

and the device is forced beyond the breakdown characteristics of its junctions, it could be damaged.

One transistor parameter we frequently measure is dc gain or beta, abbreviated h_{fo}. To a reasonable approximation, the beta of the transistor is the ratio of the collector current to the base current.

Each curve that the curve-tracer gives us represents the collector characteristics for a different base current. DC beta can be readily determined at various collector current and voltage levels. The curves in Fig. 10 show that the spacing between curves caused by the various base steps is not uniform, indicating the beta of the transistor is not uniform for large variations in collector current or voltage. Therefore, beta should be measured as the change in collector current from one step to another, caused by the change in base current from one step to another. Beta measured in this manner is often referred to as the ac beta or the h_{te} of the device. This is a better way to check a transistor because the test is made near the operating current and voltage for the device. However, this is not the high-frequency beta of the device, and does not represent the beta of the device at a few kilohertz

Once we know that a replacement transistor has enough beta, we must find out if its voltage breakdown characteristics allow it to operate successfully in the circuit. The characteristics in question are the collector to emitter voltage breakdown, V_{CB}, and the collector to base voltage breakdown, V_{CB}. The curves in Fig. 11 show the area of collector breakdown, defined as the area where the collector current becomes independent of the base current and begins to rise very sharply.

Voltage breakdown measurements must be made as rapidly as possible or

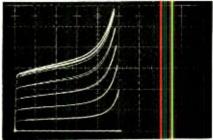


FIG. 11—A FAMILY OF CURVES for the 2N3393 showing collector breakdorn. Collector current becomes independent of the base current as the collector vol age exceeds the 30 to 40-volt region. Settings are: step generator, 0.01 mA/step; collector series limiting resistance, 200 ohrs; horizontal sensitivity, 10 volts/cm; vert cal sensitivity, 5 mA/cm.

excessive power dissipation in the transistor caused by the high collector currents and voltages used in the procedure may damage the device being tested.

To detect collector-to-base and base-to-emitter breakdowns, connect the base-collector or base-emitter terminals of the transistor to the curve tracer as though you were checking an ordinary two-terminal diods for reverse-breakdown characteristics. Do not connect the unused lead of the transistor.

When a transistor is used in relatively high-impedance circuits, the amount of leakage current may be important. This leakage current is often specified in two different forms: I_{CEO} , the collector-emitter current with the base open; and I_{CES} , the collector-emitter current with the base shorted.

To measure I_{CEO}, connect the collector and emitter leads to the curve tracer terminals and leave the base lead open. Then increase the sweep

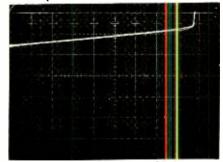


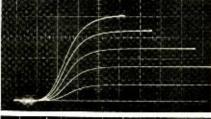
FIG. 12—A MEASUREMENT OF 100 on a 2N398A germanium pnp transister. Curve tracer settings are: collector serie i limiting resistance, 1000 ohms; horizontal sensitivity, 2 volts/cm; vertical sensitivity, 0.5 mA/cm. The step generator is not used, as the base lead is open. Germanium transistors generally have higher leakage currents than silicon. Leakage on this particular device is 800 mA with a collector-emitter veltage of 18 volts.

voltage far as possible, without exceeding breakdown, and measure the leakage current as shown in Fig. 12. If the leakage current is quite smill, you may have to use the magnifier on the curve tracer to see this current. Fre-

quently, it will not be measureable at all. If $I_{\rm CES}$ is to be determined, short the base lead to the emitter lead and make the measurement in the same way as for $I_{\rm CEO}$.

Transistors that are used in digital circuits have a few additional special characteristics, as they specify that the device may be used as a switch. When a transistor is used as a switch, the collector-to-emitter voltage when the transistor is saturated (that is, drawing its maximum collector current) is very important. For instance, if we wanted to use a transistor in a common-emitter circuit to drive the input of a series 7400 TTL gate, we would need a logic zero of at least 0.4 volt. This means that the collectoremitter voltage of less than 0.4 of a volt when sinking a maximum current of 1.6 mA from the input of the gate plus its own collector current.

To determine whether this transistor will properly drive its gates, use a curve tracer to measure $V_{\rm CE}$ (sat) or the collector-emitter saturation voltage. Figure 13-a shows the curves of an npn 2N2369 that is often used in such applications. Note that the saturation voltage increases as the collector current increases. Figure 13-b shows the same transistor, but here the base current is 100 times larger.



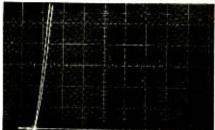


FIG. 13 — SATURATION VOLTAGE ON A 2N2369 switching transistor. a). The transistor is operated at moderate levels of base drive. Settings are: step generator, 0.02 mA/step; collector series limiting resistance, 50 ohms; horizontal sensitivity, 0.1 volts/cm; vertical sensitivity, 2 mA/cm. b). The transistor operates at high levels of the base drive, as might be found in a switching circuit. Settings are: step generator, 2 mA/step; collector series limiting resistance, 50 ohms. Horizontal sensitivity, 0.1 volt/cm; vertical sensitivity, 2 mA/cm.

In some critical applications, temperature has a great effect on transistor characteristics. One way to determine if a transistor will or will not cause problems in a circuit is to operate the transistor in a curve tracer, using collector voltages and currents that repre-

sent those of the anticipated application. Once a family of curves has been established, heat the transistor (a soldering iron, or even finger heat may be sufficient) and note any variations in these curves. With "looping", shown in Fig. 14, the characteristics of the transistor have actually changed

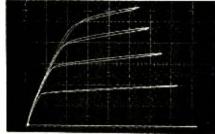


FIG. 14—THERMAL LOOPING CAUSED BY INTERNAL HEATING of the transistor. Transistor is a 2N3393, that has 200 mW dissipation. The curve tracer settings are: step generator, 0.1 mA/step; collector series limiting resistance, 100 ohms; horizontal sensitivity, 5 volts/cm; vertical sensitivity, 20 mA/cm. At the center of the display, the point where there is distinct thermal looping, represents a collector-emitter voltage of 20 volts at a current of 60 mA. This yields a power of 1.2 watts.

between the time the sweep makes the deflection from the left hand to the right hand side of the screen and its return.

In Fig. 15, we can see that with increasing collector voltages this effect can be carried to the limit, and

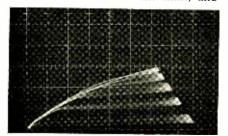


FIG. 15—THERMAL RUNAWAY CAUSED BY EXCESSIVE internal heating of the transistor. The entire characteristics of this transistor were changing as this photograph was being taken (one second exposure). The transistor was destroyed a short time later. Settings are: step generator, 0.1 mA/step; collector series limiting resistance, 50 ohms; horizontal sensitivity, 5 volts/cm; vertical sensitivity, 50 mA/cm.

the curves shown in Fig. 15 represent thermal runaway. At this stage, the transistor parameters are no longer under the control of the base current, but have completely succumbed to device heating. A transistor subjected to this test may be damaged quite rapidly, so work quickly.

When testing transistors on a curve tracer, setups should be made carefully, always starting with low initial voltages and currents, as semiconductor devices can be easily damaged. Curve tracers can produce large voltages and large currents, especially when compared to the limit parameters on small signal semiconductors.

You can destroy a transistor within the first few sweeps of an improperly set-up curve tracer.

Certain hazardous conditions exist when making measurements. Transistors can get very hot when their parameters are exceeded and severe burns can result from touching the cases of both power transistors and small-signal transistors that have been used beyond their limits.

Curve tracers can produce exceptionally high voltages to insure breakdown of most junctions; they also have fairly large current capabilities. The net result is power supplies that are potentially lethal. It is altogether too easy for a person to come in contact with leads on devices that are under test, especially those which have metal cans. Be sure to reduce the sweep voltage to zero before connecting or disconnecting the device from its test socket or leads.

When intermittent tests for transistor breakdown are desired, the A-B switch is an excellent way to rapidly control the curve tracer. To compare devices, a "standard" transistor can be left in one socket and the second socket used to interchange transistors that are being compared or sorted.

The user must remember when making in-circuit tests, that parameters may not be exactly as expected, due to other components in the circuit such as resistors and large capacitors. To make exact parameter measurements on a transistor, remove it from the circuit.

3. Field-effect transistors—Like the bipolar transistor, the field-effect transistor has two major categories of different polarity devices. Unlike the bipolar device, field-effect transistors are voltage operated devices. Initial set ups for measuring field-effect devices include changing the step generator from the current mode to the voltage mode. Today there are six major categories of field-effect devices. Their set ups are shown in the setup table (see May 75 issue). A special note should be made of enhancement-mode field-effect devices, as some curve tracers can not provide the combination of sweep polarity and step generator voltage polarity to properly display their characteristics. One method to overcome this, for example with the n-channel enhancement type, would be to use a positive collector sweep voltage and a negative step voltage. This step voltage must be offset by some positive voltage so the most negative step produces a zero gate to source voltage. One way to do this is to place a battery or an adjustable power supply in series with the gate (the base terminal) of the curve tracer.

(to be continued)

IN THE FEBRUARY 1975 AND MARCH 1975 issue of **Radio-Electronics**, we presented a general description of the TV Typewriter II, some foil patterns, the schematic of the main board and began a technical description.

This month the series will conclude with the construction details.

When the character counter reaches character slot 33, the 2⁵ and 2⁰ bits go to a one which in turn disable the "DOT CLOCK" until a new character line is started. Being in the 33rd character position also enables the video blanking circuit through IC12-c and IC5-b. Since the dot clock is stopped, the video generation ceases after the 33rd character until a new video line is started.

Now that we know how to get the data from the 2513 character generator data inputs to the screen, lets see how the incoming data is put into and accessed from memory. We must first have some means of inputting data to the TV typewriter which in most cases will be a standard keyboard/encoder with a seven-bit ASCII output. The input device must also provide some kind of a "data ready" line to tell the terminal when new data has been applied to the data input terminals. For a keyboard/encoder this is called a "keypressed strobe" line and gives us a pulse whenever a key has been depressed.

Although the seven data inputs are set up for positive logic, the "keypressed strobe" line may be either positive or negative going since NAND gate IC32-a has been provided as an optional inverter. When the "keyboard strobe" pulse reaches the "clock" input of IC9-a, it toggles forcing IC36-b, IC37-a, IC37-b, IC38-a, IC38-b, IC39-a and IC39-b to latch onto the new ASCII data provided at the data inputs, which is in turn fed to the data input terminal of the RAM memory but not loaded.

You must remember that the memory is constantly being readdressed and read and that the address of memory at the time of the "keypress strobe" is completely arbitrary and is most likely not the place where we want to store the character. Keep in mind also that we will want to input special control characters which will command the typewriter to perform a certain function but at the same time not write these control characters into memory.

The latched input character is fed to the function decode circuitry where it is determined whether or not a control function is being input. If it is, such as any input with bits 6 and 7 equal to zero or a rubout with all bits set to 1, the output of IC32 will go high forcing the output of IC11-b low

TV TYPEWRITER II

by ED COLLE

Build this new TV Typewriter. It has many new features including plug-on option boards



resetting IC9-a and preparing IC36-a to dump the input control character on the next load pulse for the "dot registers" IC23 and IC24 from IC25. Note the next time the "clock" input on IC36-a goes high it clears all of the data input latches IC36 through IC39. If on the other hand, the character is a printable character, IC32-b will stay low forcing IC11-b low thus eliminating IC9-a's clear command allowing the Q output to go to a one when toggled by the keyboard strobe. On the next "load pulse", IC16-b is clocked high. The high output of IC9-a and IC16-b are now AND'ed and prepare IC16-a to be switched on the next load pulse from IC25. When IC16-a toggles, its O output goes high setting up one of the two inputs to NAND gate IC15-b and it then waits for a "compare" command from AND gate IC3-d. The input from IC12-d is anded at the same gate just to eliminate false counts after the character counter has reached a count of 33.

The compare circuit will be discussed in detail later, but basically it determines and acknowledges when the memory is indexed to the position in which we want to store the character being processed. When the compare is confirmed, IC3-d goes high forcing IC3-b high, which forces IC15-b low. This makes IC10-a go high generating a write pulse for the memory, thus loading the character at the proper position. At the onset of

the next load pulse IC3-c goes high forcing IC11-b low which resets IC9-a and dumps the input latches, leaving the ASCII code for a blank of space stored. IC16-a and IC16-b both reset on the following load pulse.

Each input character requires 3 "load pulse" time or $4.5\mu s$ to load. Because of this requirement and the fact that only 9 load pulses per character can be guaranteed; 540 characters per second is the maximum input rate. The first 102 lines are slected twice per frame so the write speed on the 5% of each page will be doubled or 1800 characters per second.

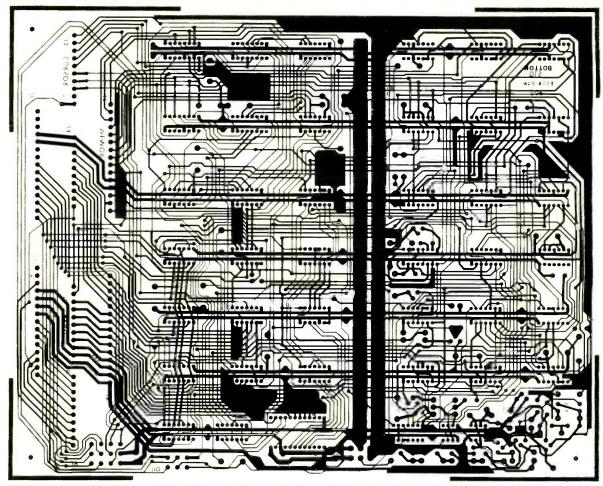
The cursor and compare circuits are very interelated since the circuitry must know where the cursor is positioned on the screen and when the memory is indexed to match with the cursor location so the cursor will blink in the right location. Since the character we will be entering through the keyboard will be entered in the cursor's position, the cursor counter also provides the address of the character we want to load into memory. The memory location of the cursor or character to be loaded into memory is stored in a 10-bit counter made up of IC35, IC27-a, IC34 and IC27-b. IC35 holds the data for the first sixteen horizontal character locations on a line and IC27-b sets if the location is on lines 17 through 32. The number of one of the 16 vertical page lines is stored in IC34, and IC27-b holds the bit adcressing one of the two pages of memory.

IC41 and IC42 are two 4-bit comparators that tell us when the data on two sets of its inputs is identical. The required 9th-bit compare is provided by IC40-c and IC40-d. The comparators are cascaded to generate one output telling whether two independent 9-bit addresses are equal, the address being that of the cursor and the location presently indexed. It is not necessary to perform a compare on the tenth or page bit because we will never be writing to or blinking the cursor on the page that is not currently accessed. The comparator circuitry monitors the address of the cursor counter and the outputs of the character counter, IC21 and IC14, and the line counter, IC7, and generates a high "compare" output when there is a match.

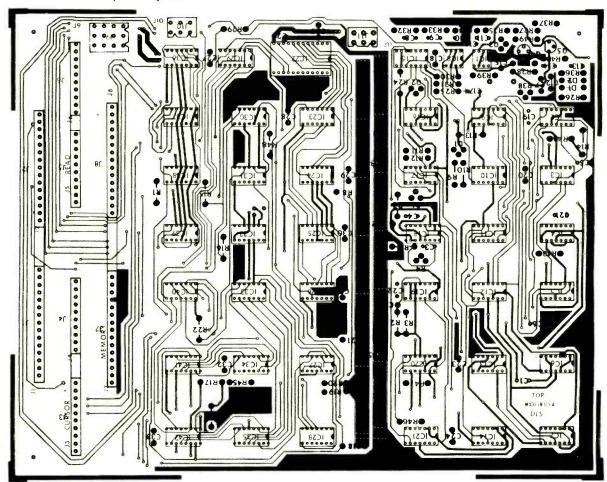
The cursor itself is generated by turning on all 35 of the character dots when AND gate IC17-c sees both a "compare" match and inactive blanking. The several times per second blinking is generated by the timer IC8 operating as an astable oscillator.

The cursor is positioned by incrementing and decrementing the up/down cursor counters IC35, IC27-a and IC34, which have full wrap around in each location and automatically

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MAIN CIRCUIT BOARD foil patterns shown half-size. Above is an X-Ray view of the double sided board. The component layout is shown below.



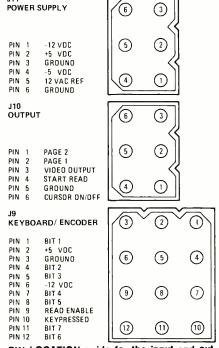
There are several cursor positioning functions provided. IC35 pin 5 and IC35 pin 4 move the cursor location one position forward and one location backward respectively. IC34 pin 5 and IC34 pin 4 move the cursor one location down and one location up respec-

(1) 10 13 IC1 2102 (10) 10 13 1C2 2102 (3) 10 IC3 2102 (2) 10 IC4 2102 (1) (7) 10 IC5 13 2102 (14) (6) 10 1C6 13 2102 1/10V 1/10V

SCHEMATIC DIAGRAM of the memory circuit is shown

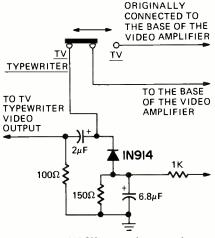
tively. IC35 pin 14 generates a carriage return and IC34 pin 14 generates a return to line 1 which means together they generate a home-up. IC34 and IC35 are responsible for line feed. The interconnected gating allows combinations to be performed with only one control command.

The erase functions have been provided for as well and do not require the optional cursor control board. Erase from the cursor position to the end of the line is initiated by setting the preset input of IC9-b low, and erase from the cursor to the end of frame is initiated by setting the preset input of IC2-a low. If either of these two latches is set, it allows IC2-b to toggle at the onset of the next compare when the row counter reaches line nine. This generates a "memory load" command which loads a space or blank from the input latches into memory. IC2-b will



PIN LOCATION guide for the input and output jacks.

TO CIRCUITRY



SWITCHING CIRCUIT permits normal operation of TV receiver or as TV Typewriter display.

reset on the first 33rd character indication from IC14 after latch IC2-b is set thus completing an erase to end of line (EOL). IC2-a will reset on the first blanking pulse from IC4-b after latch IC2-b is set, thus completing ar erase to end of frame (EOF). The resetting of either causes IC2-b to reset and return it to its initial state.

Assembly is not difficult

It cannot be emphasized enough that the best guarantee for initial and future trouble-free operation is to be extremely careful when putting the unit together.

The circuit board will be more rugged and reliable if the IC's are soldered in place on the board as shown in the photographs, but those with little experience in digital circuits, or electronic assembly might be wise to invest in some sockets; particularly for the memory IC's.

Install all of the integrated circuits, resistors, diodes, capacitors and then transistors before soldering anything. Note the components are to be mounted on the top side of the board, and the top side is marked "TOP". Double check everything to make absolutely sure all parts have been installed in their proper location and oriented correctly. Check carefully to be sure you haven't inadvertently oriented an integrated circuit incorrectly. This 13 easy to do and almost impossible to correct after soldering without ruining either the integrated circuit or the PC board, or both. When you are sure that everything has been installed correctly, then you may solder all of the component connections on the bottom of the board. All of the connections should be soldered regardless of whether cr not there are electrical connections to the pad. This helps insure that none of the integrated circuits or component leads get bent and inadvertently short out to near-by foil conductors.

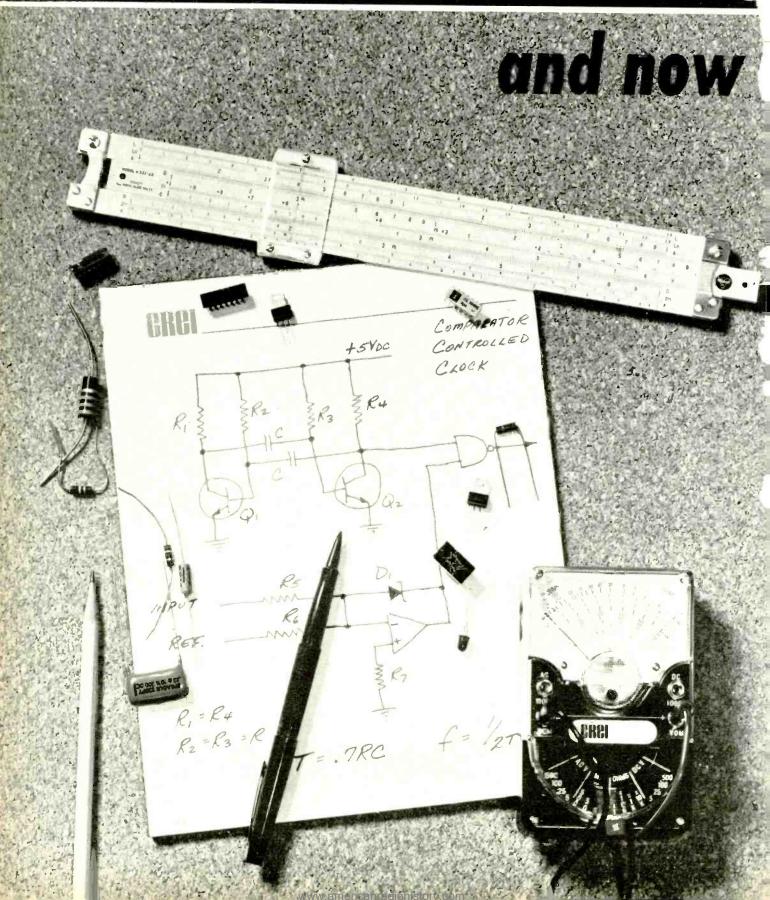
Now is the time to carefully check the entire board to be sure that all connections where applicable have been soldered. Make sure also that there are no solder bridges, or improperly installed components.

Follow the same procedure for assembling the memory board as you did for the main circuit board. The memory integrated circuits are MOS devices which are very intolerent of static electricity so be sure to take appropriate precautions. Here again be sure to check over the board very carefully after assembly to be sure there are no mistakes.

Attach all of the wires to the connector plugs for the power supply, J11, output, J10, and keyboard, J9. Use the connector drawing to show the appropriate pin connection for each of the (continued on page 87)

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RADIO-ELECTRONICS

Step-by-step TV Troubleshooters Guide

With the increasing number of manufacturers using integrated circuits in their television receivers, it's important for the service technician to know how these devices work.

by STAN PRENTISS

EVEN THOUGH SYLVANIA'S NEW GT-MATIC has a unique 31.5 kHz IC oscillator, other sections can develop an interesting problem or two. I was all set to do a narrative on Sylvania's well-engineered E03, E04, and E05 chassis (all pretty much the same except the E04 has electronic tuning) when the night before story time, my E05 popped its circuit breaker with the switch off. At least it popped first with the switch on then repeated continuously with the switch off. And, as any service technician familiar with semiconductors can tell you, this means only one possible thing—a

short! How fortunate that this receiver is completely guarded by a circuit breaker. On the other hand, what do you do with a dead set? Well, like Sherlock Holmes, you look for clues.

Trouble tips

Most of us are blessed with two eyes, and an ohmmeter is a common electronic tool. So let's not rush off and tear up the set. Go back and consider your basic symptom: that the circuit breaker trips no matter what position the off-on switch is in. This means that the fundamental

problem has to be in some circuit that isn't really controlled by the off-on switch—and that, of course, is the picture-tube filament transformer that's on all the time. Refer to the schematic diagram of the power supply in Fig. 1. With switch S502-b in the OFF position, R504 limits the picture-tube heater voltage to about 4.8 volts. With S502-b in the ON position (closed), heater voltage measures a full 6.3 Vac, plus +36 Vdc connected through R506 (150K) to reduce heater to cathode arcs.

With ac applied to the 120 V interlock,

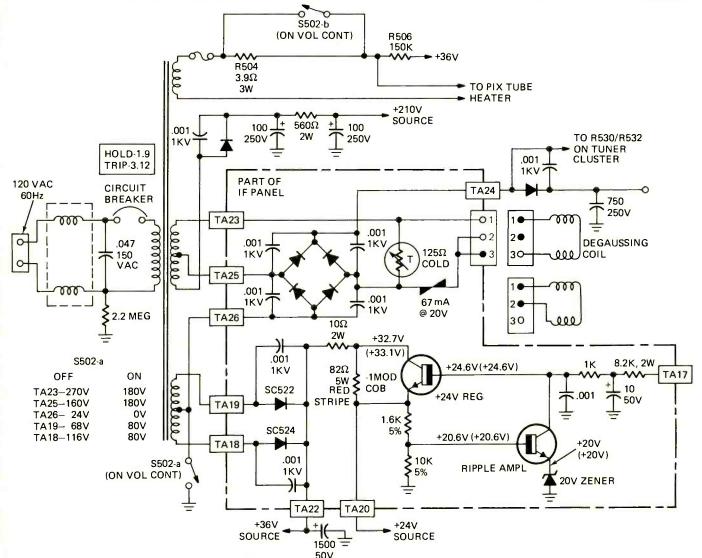


FIG.1—POWER SUPPLY schematic of Sylvania's EO3 and EO5 chassis.

FIG. 2—WAVEFORMS OF POWER SUPPLY shown in Fig. 1. Upper waveform is taken from TA-18, while lower waveform is at TA-25. The scope is set at 50V/div.

the power transformer hums a few seconds before the circuit-breaker pops. Does this indicate a bad transformer? Usually no—basically it's a sign that too much current is flowing and setting up vibrations in the transformer laminations. This is often caused by other circuit faults.

Trouble shooting

Unfortunately, a few initial ohmmeter checks at terminals TA18 through TA26 and a random front-to-back check of sev-

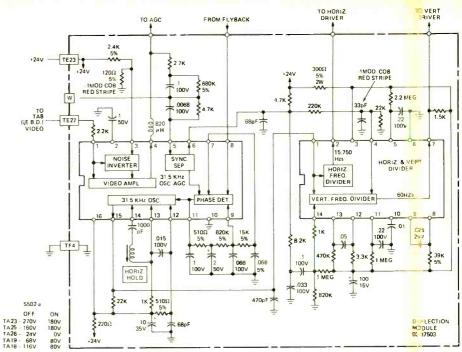


FIG. 3—IC300 and IC400 vertical and horizontal countdown IC's, block diagram and peripheral components.

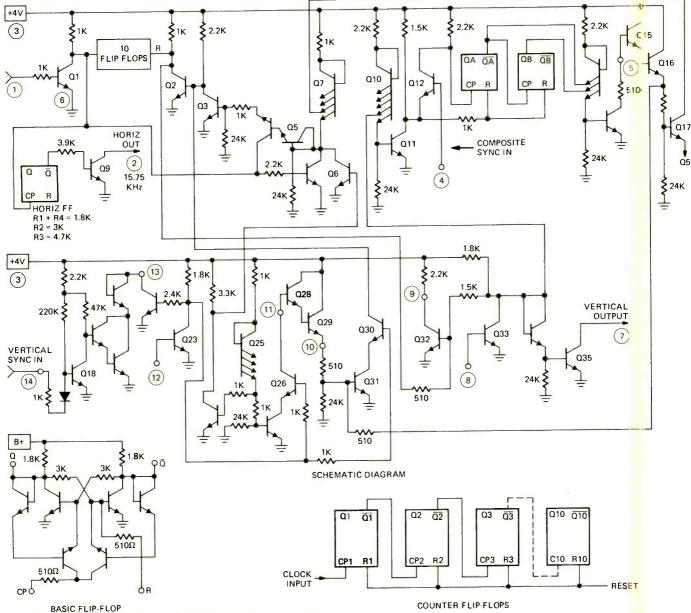
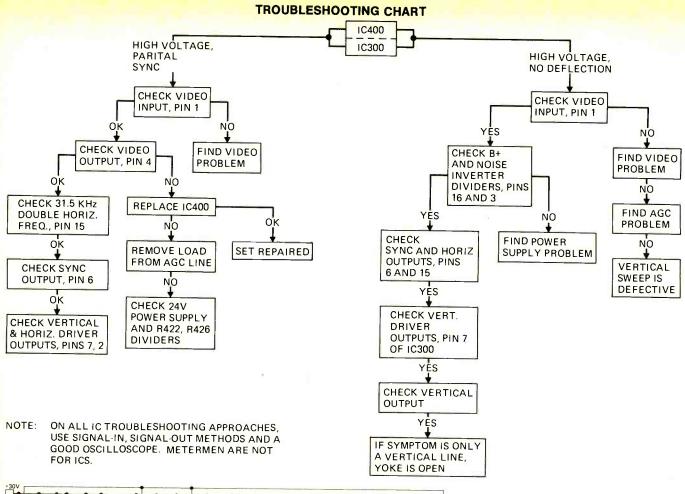


FIG. 5—IC300 HORIZONTAL AND VERTICAL countdown circuits.

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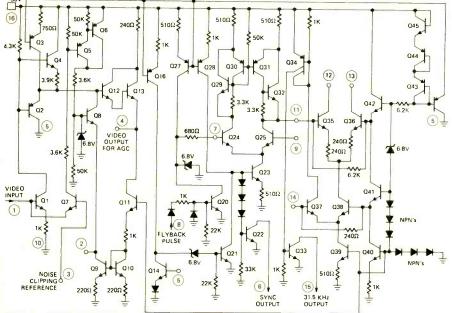


FIG. 4-IC400 SCHEMATIC DIAGRAM.

eral diodes revealed nothing. Disconnecting the picture-tube heater connections and applying power wasn't helpful either. With S502 on or off, the circuit-breaker still tripped. So, when all's said and done, you have one of two conditions-either the transformer is shorted, or there are problems somewhere across the 150K resistor that ties the +36 V source to the picture-tube heater. There is one sure way to find out, however, but you've got to be extremely careful. Specs on the circuit breaker says that it trips at 3.12 amps. Supposing that the transformer is all right. Put a 4 or 5 ampere fuse in place of the

circuit breaker and watch for smoke. With the set plugged in, wisps of telltale burning aren't long in coming.

In this case, smoke was quicker than the eye. It took a minute or two of probing before diode SC522, half of the fullwave rectifier for the 36 volt source, was discovered burned in two. Since ohmmeter checks revealed no low readings to ground at any of the power board's critical points, we can assume SC522 had developed leakage. Even though the centertap of the winding feeding it was open through S502-a, this diode (at least) was passing (continued on page 78)

R-E's Substitution guide for replacement transistors

PART XXV 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 Electronic Components, Harrison, N.J. 07029

-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 up-dated the listing to include them. The first part of this Guide appeared in March 1973.

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	#EN
2N5784 2N5785 2N5786 2N5787 2N5788	NA NA RS276-2025 NA NA	TS-3002 TS-3010 T-242 NA NA	NA GE-86 GE-28 NA NA	ICC-S3002 ICC-S3010 ICC-242 NA NA	NA NA NA NA	NA NA PTC 142 NA NA	HEP-S3002 HEP-S2010 HEP-242 NA NA	SK 3024 SK 3024 SK 3024 NA NA	RT-154 RT-154 RT-154 NA NA	NA NA ECG 186 ECG 5400 ECG 5401	WEP-WS3002 WEP-WS3003 WEP-242 NA NA	NA Z:N 207 NA NA NA
2N5789 2N5790 2N5804 2N5805 2N5806	NA NA NA NA	NA SR-1005 T-707 T-707 SR-1473	NA NA NA NA	NA ICC-R1005 ICC-707 ICC-707 ICC-R1473	NA NA NA NA	NA NA PTC 118 PTC 118 NA	NA HEP-R1005 HEP-707 HEP-R1473	NA NA NA NA SK 3509	NA NA NA NA	ECG 5402 ECG 5404 ECG 162 ECG 162 ECG 5543	NA NA WEP-707 WEP-707	NA NA ZIN 204 ZIN 204 INA
2N5807 2N5808 2N5809 2N5810 2N5811	NA NA NA RS276-2009 RS276-2021	SR-1475 NA NA T-53 T-51	NA NA NA GE-20 GE-67	ICC-R1475 NA NA ICC-53 ICC-51	NA NA NA NA	NA NA NA PTC 136 PTC 127	HEP-R1475 NA NA HEP-53 HEP-51	SK 3509 SK 3509 SK 3509 NA NA	NA NA NA RT-100 RT-101	ECG 5545 ECG 5546 ECG 5547 ECG 123A ECG 129	NA NA NA WEP-53 WEP-51	NA NA NA Z:N 102 Z:N 101
2N5812 2N5813 2N5814 2N5815 2N5816	RS276-2009 RS276-2021 RS276-2009 RS276-2021 RS276-2009	T-736 T-716 T-736 T-716 T-736	GE-63 GE-67 GE-20 GE-67 GE-20	ICC-736 ICC-716 ICC-736 ICC-716 ICC-736	NA NA NA NA	PTC 123 PTC 127 PTC 136 PTC 127 PTC 136	HEP-736 HEP-716 HEP-736 HEP-716 HEP-736	NA NA NA NA	RT-109 RT-115 RT-100 RT-115 RT-100	ECG 128 ECG 159 ECG 128 ECG 159 ECG 128	WEP-736 WEP-716 WEP-736 WEP-716 WEP-736	ZEN 120 ZEN 107 ZEN 120 ZEN 107 ZEN 120
2N5817 2N5818 2N5819 2N5820 2N5821	RS276-2021 RS276-2009 RS276-2021 RS276-2018 RS276-2025	T-716 T-736 T-716 T-243 T-242	GE-67 GE-63 GE-67 GE-63 GE-67	ICC-736 ICC-736 ICC-716 ICC-243 ICC-242	NA NA NA TR-25 TR-28	PTC 127 PTC 136 PTC 127 PTC 136 PTC 127	HEP-736 HEP-736 HEP-716 HEP-243 HEP-242	NA NA NA SK 3024 SK 3025	RT-100 RT-100 RT-115 RT-114 RT-115	ECG 128 ECG 128 ECG 159 ECG 128 ECG 129	WEP-736 WEP-736 WEP-716 WEP-243 WEP-242	ZEN 107 ZEN 120 ZEN 107 NA NA
2N5822 2N5823 2N2824 2N5825 2N5826	RS276-2018 RS276-2025 RS276-2013 RS276-2013 RS276-2013	T-243 T-242 T-729 T-729 T-728	GE-63 GE-67 GE-62 GE-62 GE-62	ICC-243 ICC-242 ICC-729 ICC-729 ICC-728	NA NA NA NA	PTC 136 PTC 127 PTC 121 PTC 121 PTC 121	HEP-243 HEP-242 HEP-729 HEP-729 HEP-728	NA NA NA NA	RT-114 RT-115 RT-109 RT-109 RT-109	ECG 128 ECG 129 ECG 123A ECG 123A ECG 123A	WEP-243 WEP-242 WEP-729 WEP-729 WEP-728	NA NA ZEN 115 ZEN 115 ZEN 114
2N5827 2N5828 2N5829 2N5830 2N5831	RS276-2013 RS276-2013 NA RS276-2008 RS276-2008	T-728 T-738 NA TS-0005 TS-0005	GE-62 GE-62 NA GE-20 NA	ICC-728 ICC-738 NA ICC-S0005 ICC-S0005	NA NA NA NA	PTC 121 PTC 123 NA NA NA	HEP-728 HEP-738 NA HEP-S0005 HEP-S0005	NA NA NA SK 3018 NA	RT-109 RT-109 NA RT-114 NA	ECG 123A ECG 123A NA ECG 123A NA	WEP-728 WEP-728 NA WEP-712 WEP-712	ZEN 114 ZEN 121 NA NA NA
2N5832 2N5833 2N5834 2N5838 2N5839	RS276-2008 RS276-2008 NA NA NA	TS-0005 TS-0005 TS-3031 T-707 T-707	NA NA NA NA	ICC-S0005 ICC-S0005 ICC-S3031 ICC-707 ICC-707	NA NA NA NA	NA NA NA PTC 118 PTC 118	HEP-S0005 HEP-S0005 HEP-S3031 HEP-707 HEP-707	NA NA NA NA	NA NA NA NA	ECG 194 ECG 194 ECG 189 ECG 162 ECG 162	WEP-712 WEP-712 WEP-WS3031 WEP-707 WEP-707	NA NA ZE № 204 ZE № 204
2N5840 2N5844 2N5845 2N5847 2N5848	NA NA NA NA	T-707 T-715 TS-0004 NA NA	NA NA GE-20 NA NA	ICC-707 ICC-715 ICC-S0004 ICC-S0006 ICC-S0007	NA NA NA NA	PTC 118 NA PTC 136 NA NA	HEP-707 HEP-715 HEP-S0004 HEP-S0006 HEP-S0007	NA NA NA NA	NA RT-115 RT-114 NA NA	ECG 162 ECG 159 NA ECG 194 NA	WEP-707 WEP-715 WEP-56 WEP-717 WEP-735	ZE 1 204 ZE 1 106 ZE 1 127
2N5851 2N5852 2N5853 2N5854 2N5855	NA NA NA NA	T-720 T-720 TS-5005 TS-5005 TS-3031	NA NA NA NA	ICC-720 ICC-720 ICC-S5005 ICC-S5005 ICC-S3031	NA NA NA NA	NA PTC 121 NA	HEP-720 HEP-720 HEP-S5005 HEP-S5005 HEP-S3031	NA NA NA NA	RT-105 RT-105 NA NA RT-115		WEP-720 WEP-720 WEP-WS5005 WEP-WG 5005 WEP-WS 3031	ZE 109 ZE 109 1A 1A 1A
2N5856 2N5857 2N5858 2N5859 2N5860	NA NA NA NA	TS-3020 TS-3031 T-714 TS-3002 TS-3002	NA NA NA NA	ICC-S3020 ICC-S3031 ICC-714 ICC-S0002 ICC-S0002	NA NA NA NA	PTC 141 PTC 144	HEP-S3020 HEP-S3031 HEP-714 HEP-S0002 HEP-S0002	NA NA NA NA	RT-114 RT-115 RT-144 RT-102 RT-102	ECG 188 ECG 189 ECG 190 ECG 192 ECG 192	WEP-WS3020 WEP-WS 3031 WEP-WS3021 WEP-735 WEP-735	TIA TIA TIA TIA
2N5861 2N5864 2N5865 2N5867 2N5868	NA NA NA NA	TS-3002 TS-3012 TS-3012 TS-5007 TS-5005	NA NA NA NA	ICC-S0002 ICC-S3012 ICC-S3012 ICC-S5007 ICC-S5005	NA NA NA NA	NA NA PTC 141 NA NA	HEP-S0002 HEP-S3012 HEP-S5007 HEP-S5005	NA NA NA NA	RT-102 NA NA RT-153 NA		WEP-735 NA NA WEP-WS 5007 WEP-WS 5005	LIA LIA ZELI 211 LIA
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2N5874 2N5875 2N5876 2N5877 2N5878	NA NA NA NA	TS-5004 T-248 T-248 T-247 T-247	NA NA NA NA	ICC-S5004 ICC-248 ICC-248 ICC-247 ICC-247	NA NA NA NA	NA NA NA NA	HEP-S5004 HEP-248 HEP-248 HEP-247 HEP-247	NA NA NA NA	NA RT-165 RT-165 RT-131 RT-131	ECG 219	WEP-WS5004 WEP-WS 7001 WEP-WS 7001 WEP-247 WEP-247	HA HA HA HA
2N5879 2N5880 2N5881 2N5882 2N5883	NA NA NA NA	T-248 T-248 T-247 T-704 TS-7001	NA NA NA NA	ICC-248 ICC-248 ICC-247 ICC-704 ICC-S7001	NA NA TR-21 TR-21 NA	NA NA NA NA	HEP-248 HEP-248 HEP-247 HEP-704 HEP-S7001	NA NA SK 3024 SK 3024 NA	RT-165 RT-165 RT-114 RT-114 RT-148	ECG 130 ECG 130 ECG 128 ECG 128 NA	WEP-WS 7001 WEP-WS 7001 WEP-247 WEP-704	RA RA RA

curve traver or lab-type transistor checker. NA=NOT AVAILABLE

ARCH

2N5884

DM

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APRIL 1975

RE's Service Clinic

Servicing Electronic Organs

They are not as difficult as they look

by JACK DARR SERVICE EDITOR ELECTRONIC ORGANS AREN'T HARD TO repair. Any radio-TV shop can find and fix troubles, using only standard TV test equipment. Although they look complicated, they use only standard audio circuits; tone generators, wave-shaping networks, power amplifiers. (Actually, they don't look as complicated as the back view of one of the big stereo-theater consoles, with remote controls!) Tube and transistor electronic organs use the same basic circuits, with the usual differences.

Most organs use the master oscillator-frequency divider system. A tunable oscillator circuit, generally a Hartley, generates the highest frequency note. This is then fed to a series of frequency dividers. This is possible because of an inherent characteristic of music. Each note is exactly one-half of the frequency of the same note in the octave above it. Example: middle A is 440 Hz. The next higher A is 880 Hz and the next lower A is 220 Hz.

The first electronic organs used vacuum-tube circuits (and many, many tubes! 12AX7's all over the place!) Figure 1 shows a typical divider circuit using one-half of a 12-AX7. The master oscillator output is

22K
OUTPUT
TO KEYS
OUTPUT
TO KEYS
OUTPUT
COUPLING
CAPACITOR

TO NEXT
DIVIDER

1 12 AX7
FEEDBACK
COUPLING
CAPACITOR

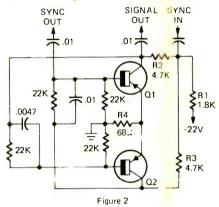
PLATE
CAPACITOR
OR
470K

FIGURE 1

shaped into a rounded-corner sawtooth. The peaks of this are used to sync the divider stage. The time-constant is designed so that this stage delivers one output sawtooth for every two sync-pulses from the stage before it. So, it divides by two.

The transistor organs use a circuit that's a natural for frequency division. This is a bistable multivibrator, or flipflop. This circuit divides by two with the greatest of ease; the first syncpulse from the preceding stage makes

it *flip*, then the next one makes it *flop*. To divide by two, we take the output from flop, and there you are. Figure 2 shows a typical flip-flop, as used in Magnavox transistor organs.



The basic signal in both electronic organs is the sawtooth. This gives the characteristic organ sound. The output of the tube divider is a sawtooth, and the flip-flop output is usually almost a square wave. This can easily be shaped into the desired sawtooth.

This is done in the voicing circuits. These are wave-shaping networks, some including amplifiers. Figure 3 shows some of the typical filters used. The low-pass circuit of Fig. 3-a is used to produce the Flute; the h gh-pass filter of Fig. 3-b is used for the violin

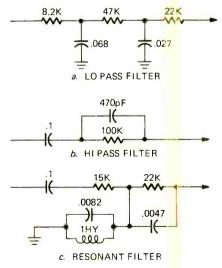


Figure 3

and viola tones, and the resonant filter of Fig. 3-c for such tones as hern and reed. From the output of the voicing unit, we go to an audio amplifier.

The keyboards of an organ aren't

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. If return postage is not included, we cannot process your question. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, N.Y. 10003.

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Circle 21 on reader service card

called keyboards; they're called manuals. In older models, the top one is the Swell manual and the lower one the Great manual. Some later units call the top one the Solo and the lower the Accompaniment. The different voices are controlled by tabs, and guess what they're called. Tabs! Incidentally, for the complete novice, when you start to check out an organ by playing it, be sure that at least one tab is in the ON position for each manual. In some organs, if they are all up or off, you may not hear anything when a key is pushed down. (The preceding data is included so that you'll have a better chance of knowing what the organist is talking about when she calls you for service! You gotta speak the language.)

To make a first check for trouble, turn the organ on. Check to see that one tab is down, for example, the flute or diapason on the top, and the horn on the lower manual (The tabs are in two groups of 5 or 6, one for each manual). Now, look under the organ; you'll see a foot-pedal. To us, it's a volume control, but they call it an expression pedal. The pedals control the bass, and look like a big wooden keyboard! Now, run up and down the keyboard and see if each note sounds, and how it sounds. You'll be able to tell, even if you're no more

musical than I am.

One common trouble is a defective frequency divider. The clue to this is when higher notes sound all right, for example the two high A's. However, the third A may sound the same (frequency) as the second! In most cases, the third note will have a burbling sound. Check the third divider, or whichever one is burbling. This type of trouble in tube organs is most often due to leaky capacitors or resistors which have changed value, thus upsetting the time-constants of the stage. When one note burbles, all of the same notes lower than it will burble too.

To check the voicing circuits, put each tab down, by itself, and run up and down the keyboard. Each one should have a definite effect on the sound. If you lose the sound completely when any tab is pushed down, check for a broken wire, open transistor in the bus amplifier, etc.

If you have any doubts as to whether any master oscillator isn't working, check it with a scope. In some organs, such as the Magnavox transistor organ, you can connect a jumper lead with a 100K resistor in series to the audio amplifier input. Touching this to the signal-output leads of any tone generator will produce this tone in the speaker, if it is working. You are by
(continued on page 76)

10MHz 5" scope with easier calibration and voltage measurement



Model 1465 \$428

Here are some B&K extra touches. Besides DC-to-10MHz bandwidth, triggered sweep, automatic sync, 16.6mV/cm vertical sensitivity, DC-coupled amplifier and front-panel Vectorscope capability, Model 1465 also has 5X magnification to increase sweep speed to 0.2usec/cm for complex waveform analysis. And Cali-Brain®, which collapses horizontal sweep to let you measure instantaneous peak-to-peak voltage easily while simultaneously displaying the full-scale voltage range. Now in stock at your local distributor or write Dynascan.



•

Circle 22 on reader service card

You'd probably expect a portable oscilloscope as rugged and reliable as this one to cost a lot.

You'd be wrong.

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\$18900



Very good equipment at a very good price.

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Circle 23 on reader service card

Introducing the expensive curve tracer that doesn't cost a lot.

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It's a lab-quality instrument that provides fast analysis of all semiconductors including J-FET's, MOS-FET's, signal and power bipolar transistors. SCR's, UJT's and diodes.

You can test transistors in circuit for GO/NO GO condition. Badly distorted curves will indicate the stage where a defective transistor or other faulty component exists.

The 501A is complete—with scope graticule and FP-3 probe for fast, one-handed in-circuit testing. It generates true current and voltage steps, with 3% accuracy, for measuring beta at all current levels.

And it has a sweep up to 100 volts and 100 milliamperes.

With the 501A, curves are displayed on an auxiliary scope screen. And you can hook it up to any scope—old or new.

All three controls can be set in quick-test positions to test and evaluate 90% of all solid-state devices without manufacturer's data sheets.

The 501A won't burn out either the semiconductors or itself.

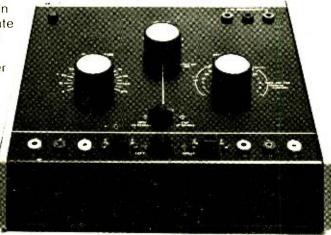
With all these features, you'd think the 501A was an expensive curve tracer. But look at the price.

For complete technical data, call your B&K distributor. Or write Dynascan Corporation.

Very good equipment at a very good price.



Product of Dynascan Corporation 1801 West Belle Plaine Avenue, Chicago, Illinois 60613 \$163⁰⁰



change in the frequency.

frequencies.

passing the voicing circuits.

Electronic organs have a true vibrato effect. Although guitar amplifiers use the terms vibrato and tremolo interchangeably, in music they are not. (They do sound a lot alike, though!) Vibrato is a periodic variation in the frequency (pitch) of a note, and tremolo is a periodic variation in its volume. Organs get a true vibrato by feeding a slowly-varying dc voltage (about 6-8 Hz) to the base of the master oscillator. This causes a small

This is easy to check. Just hold any key down, and turn the vibrato switch on. You'll hear it. Some have a vibrato control; if you don't hear the vibrato, check to see that this isn't turned all the way off. The vibrato oscillator is just a very low-frequency multivibrator. You can identify it by the very large capacitors and resistors used for coupling. In fact, you can often check a vibrato oscillator with a dc voltmeter; the needle will vibrate visibly. A scope will usually show an almost straight line moving up and down.

All in all, after you get used to the things, they're not at all hard to service. You can do anything except tune

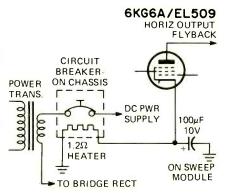
them. This is seldom needed, but when it is, a complicated strobe instrument is the only way. For normal repairs, just sit down at the keyboard and start looking for the Lost Chord. (I found it once, but I lost it again.) Just push the keys and find out what is working and what isn't! then look in the back to find out why. As the old saying goes, "Try it! You'll like it!" R-E

reader questions

ELECTROLYTIC BLOWS

The customer said there was a Bang, and this Truetone WEG-2297-A27 went out. When I turned it on, I got a weird raster, with a dark spot in the center. Opening it up, I found that a small electrolytic capacitor on the high-voltage sweep module had exploded. It's connected to the cathode of the 6GK6 horizontal output. I replaced it, and the new one exploded, too! I have no schematic on this set. What's causing this?—G.W., Waldron, AR.

Schematic on this one is in Sams 1216-3. This capacitor is apparently



used to bypass the horizontal output tube cathode. It returns to ground through a little heater in the *circuit breaker*. If this heater is open, the pulse voltage will blow this little capacitor; 100-µF, 10V. Check from pin 2 of the sweep module to ground for not more than 1.3 ohms.

SCOPE PROBLEM

In an old Supreme 546 scope, I get about 1/2 inch vertical deflection without input. Focus control has practically no effect. What does this?—E.S., New Ringgold, Pa.

Probably a resistor changed value in that long network from the negative high-voltage supply. Most likely one, that 470,000-ohm unit between the focus control and the focus pin on the 3AP1 base. (continued on page 94)



The FM-2400CH with its extended MHz. The range covers 25 to 1000 frequencies can be those of the radio frequency channels of operation and/or the intermediate frequencies of the receiver between 5 MHz and 40 MHz.

Frequency Stability: ± .0005% from +50° to +104°F.

Frequency stability. ± 10003 moin +30 to +104 ft. Frequency stability with built-in thermometer and temperature corrected charts: ± .00025% from +25° to +125° (.000125% special 450 MHz crystals available).

Self-contained in small portable case. Complete solid state circuitry. Rechargeable batteries.

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Circle 28 on reader service card

AUDIO SIGNALS

(continued from page 39)

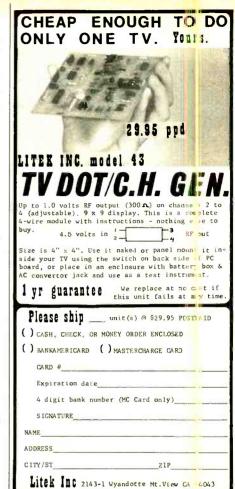
frequencies of about 30 MHz. The EIA bulletin, like the earlier FCC bulletin, suggests bypassing the output circuit to ground with ceramic capacitors. A properly stabilized audio amplifier can withstand fairly large values of capacitance across the speaker terminals without oscillating, and the low impedance of the output circuit precludes any loss in high-frequency response because of such capacitive bypassing. Nevertheless, if you have doubts about the relative stability of your amplifier under conditions of such capacitive loading, the best thing to do is to observe the output at the speaker terminals on an oscilloscope. Do this for several positions of the master volume control while musical program material is being played and watch for any evidence of high frequency "blips" superimposed on the low-frequency audio waveforms. Normally, the value of capacitance needed to eliminate rf interference at this point should be low enough so as not to cause oscillation, but it's a good idea to check this out before you discover that some super-audible high-frequency oscillation has burned out the tweeters in your speaker systems.

There is no single solution to the

problem of audio rectification in hi-fi component equipment, and we have suggested just a few things that may help. Undoubtedly, many readers have been plagued with these kinds of interferences and may have worked out unique solutions to specific problems. Perhaps those of you who have faced and solved the problems of interference would like to share your solutions with others. If so, please tell us how you solved the problems, preferably naming the equipment involved, and we'll devote more space to this subject in a future article. R-E



"Would you go for a malfunction in my electronic calculator"



Circle 29 on reader service card

You don't have to buy a new car to get an electronic ign<mark>it</mark>ion

West of the second of the seco



Let's face it. After 37 years, even a Phantom II can use a lift. That's why I put a Delta Mark Ten B Caracitive Discharge Ignition on my Phantom . . . to give he a spark I'd pit against any '75 model car. I went to Delta because they aren't Johnny-come-latelys. Delta's been making electronic ignition systems for over a decade.

Whatever kind of car you drive, you can give it the same great Delta performance I gave mine.

- Mark Ten B Capacitive Discharge Ignition Systems are manufactured by Delta Products, Inc., a comularly with a conscience, and with a proven record of reliatility both in product and in customer relations.
- The Mark Ten B really does save money by eliminating the need for 2 out of 3 tune-ups. Figure it out for yourself. The first tune-up or two saved pays for the unil, the rest is money in your pocket. No bunk!
- Because the Mark Ten B keeps your car in better tune, you actually can save on expensive gasoline.
- With a Mark Ten B, spark plugs stay clean and last longer . . . fouling is virtually eliminated.



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Mark Ten B. assembled Mark Ten B, kit

\$64.95 ppd \$49.95 ppd

Standard Mark Ten, assembled Deltakit(R) Circle 61 on reader service card

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Circle 62 on reader service card

STEP-BY-STEP

(continued from page 70)

enough current to open the circuit breaker. In replacing SC522, I noted that its part No. had been changed to another diode from 13-17174-2 to 13-29165-2-45. The +36-volt bus supplies both the horizontal driver and the push-pull audio outputs.

Operationally, you'll find there is 2 Vp-pripple at the output cathode connections of the two diodes; but don't be alarmed, that's normal. Figure 2 shows the normal waveforms that should appear at TA18 and TA25, with the receiver plugged in and switched on. Each at 50V/div., the top waveform is TA18 and the bottom TA25—ac volts only. Then on Fig. 1, you'll see a list of the ac p-p inputs to the power rectifiers; \$502-a both on and off.

Sylvania's effective sync IC's

This article was supposed to be about some nifty circuits in the GT-Matic. These circuits contain IC's. You may not necessarily want to specialize in integrated circuits, but the day is coming, and soon, when a working knowledge of what they are and what they do can mean technical survival. In Fig 3, the video amplifier, noise inverter, 31.5-kHz oscillator, sync separator, and phase detector are all shown in the IC400 block diagram. The IC400 block diagram shows you "who and what," but it does not tell you "how" it works

Figure 4 shows the schematic diagram of the IC400 integrated circuit. Video enters pin 1 and the emitter of Q7 in negative phase. The video is inverted by Q1 and buffered by Q4 before it is applied to the base of Q12 (Q2 and Q3 are bias sources, with Q3 a base dc reference from point "S"). Without noise, the video signal is amplified by the Darlington configuration (Q12 and Q13) for a video agc output.

Video output is through pin 4 for age and is also returned through an RC bias network (Fig. 3) to the base of Q14 (Fig. 4), permitting only positive sync tips to forward bias this transistor, whose active load is Q16. Sync is inverted and amplified through a coupling Zener to Q21, where it is again inverted and applied both to the base of sync output Q22, and the base of current source Q23. Q28 is an active load. At the same time, a flyback comparison pulse is diodecoupled to the base of Q20 (pin 8), is inverted and appears at the base of Q24. Transistors Q24 and Q25 form a differential amplifier, which compares sync and flyback phase. Any difference voltage is fed to the base of Q35 as a correctional voltage. Transistors Q35, Q36, O37, O38, and O39 (the constant current generator) all form a stable 31.5 kHz oscillator. The load resistors connect to pins 12 and 13 (see fig. 3), and the L420 oscillator (horizontal hold) coil is connected between pins 13 and 14. Output is through multiple collector Q34, to Q33, and pin 15.

Count down IC300

A stable 31.5-kHz signal has been developed which is independent of stationgenerated sync and flyback phase comparison. It's now necessary to establish the precise 59.94-Hz field and 15,734-Hz line repetition rates that all television receivers must have for compatible vertical and horizontal deflection.

The 31.5 kHz output from IC 400 enters pin 1 of IC300 (Figs. 3 and 5), is amplified and inverted by transistor Q1, and routed both to the count down group of 10 flip flops (one of which is shown at the lower left corner of Fig. 5), and also to a single divide-by-two flip flop at the base of Q9. The IC400 31.5-kHz is now halved to 15,734 Hz and amplified by Q9 as the horizontal repetition rate drive pulse which, in turn, energizes the horizontal driver.

The chain of 10 flip flops are what digital logic people call a ripple counter since each stage drives another, and all succeeding stages operate at half the frequency of their driver or clocking stage. This means that 10 dividers will divide by 210 or 1024. However, all that's needed is a line count of 525 (262.5 lines for each field), and something additional for possible sync correction. So at the 9th flip flop, the count down from 31.5 kHz amounts to just about 60 Hz, and that's the frequency needed.

There are 10 flip flops in the chain instead of 9, however, so something must turn off the counter following the 9th flip flop. This is done by the gating circuits at the top right and center of Fig. 5. The vertical sync signal comes in at pin 14 and applied to the base of Q18. Also, composite sync is applied to pin 4 and the base of Q12. Without doing a complete timing diagram which would be surprisingly tedious, detected interlace pulses will operate the QA-QB flip flops so that Q15 thru Q17 will gate Q7. When this occurs the Q5, Q3, group resets the 10 flip flops at point R. This produces the sought-after 525 count that induces normal sync output at Q35 as Q32 turns on and Q33 turns off. The positive output pulse at Q33 also cuts off Q10, which causes Q11 to stop conducting and the QA-QB pair of flip flops in the 525 line reset counter are reset.

When no interlace signals are detected, the vertical sync input chain takes over, as well as Q25, Q26, Q28 etc. When reset fails to occur at 525 lines, coincident pulses arrive from Q23 (vertical sync input), Q29, and Q16 (the 525 counter): so that Q30 and Q31 become an AND gate. When this occurs, Q2 is cut-off and produces a reset signal at point R as the collector voltage of O2 rises toward the 4V source supply. At this point, the maximum count is 541, and the counter runs at such a rate until an interlace signal is again detected. Such gating is necessary where there are unusual noise or electrical interruptions, or where composite video originates from a source other than a broadcasting station that has no interlace sync. This could be a closed-circuit camera, some community cable systems, or other local varieties of signal origination which do not have broadcast quality transmitters. Counter flip flops at the bottom of Fig. 5 show how all 10 FF's of the count down chain are connected.

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.

IC MULTIMETER, PM2503, features voltage range protection up to 2 kV, automatic polarity with indication and linear scales for all ranges. Minimum 10 megohm input impedance provides virtually no-load measurements at 3% worst case accuracy. Circuitry allows linear scales to be used for all measurements except dB. Other features include: separate readings of dc and ac components of measured signals, pushbutton ac/dc



selection, single rotary switch for range selection and V-ohm on the same input sockets.

Has ac/dc current ranges of 1 μA to 1A, ac/dc voltage ranges of 100 mV to 1 kV and resistance ranges (also with linear scales) of 100 ohms to 10-megohms. Plastic housing is lined with layer of conductive material connected to meter's ground for protection against induced rf. Core construction of meter movement guards against stray magnetic fields. No zeroing or infinity adjustments are required; uses standard 9-volt batteries to supply 1000 working hours before replacement. \$169.00—comes complete with measuring leads and spare fuses incorporated inside.—Philips Test & Measurement Instruments, Inc., 400 Crossways Park Drive, Woodbury, NY 11797.

Circle 31 on reader service card

AUTOMATIC TURNTABLE, model 351 features industry's widest umbrella spindle that eliminates double record drop, record hangups or slanting of unbalanced records. Contains bi-directional viscous-damped cueing and counterbalanced pickup arm that operates on a horizontal and vertical gimbal bearing system. This system assures minimal friction in both vertical and horizontal planes. Slide-in cartridge adaptor facilitates cartridge change.

Other features include an anti-skate device for both spherical and elliptical stylus settings, gravity stylus pressure adjustment that contains no variable springs and a 4-

pole synchronous motor. Complete with uniplanar design wherein most moving parts have been placed on single horizontal plane. Tracking is ¼ gram. Unit comes equipped with a Shure M91E cartridge, ellip-



tical diamond stylus, walnut grain base and smoke-tinted hinged protective dustcover. Supplied with rotating manual spindle that eliminates record hole wear. When stub spindle is used, record plays once automatically, arm returns to rest position and turntable shuts off, \$160.00—Glenburn Corp. 787 Susquehanna Avenue, Franklin Lakes, NJ 07417.

Circle 32 on reader service card

RECORD CLEANER, *model AT6008*. Use on CD-4 discs as well as conventional 2-channel recordings and matrix 4-channel records. Comprised of velvet-surfaced cleaning unit



with handle, storage base, cleaning brush, special cleaning solution and solution applicator. Foam-backed velvet surface, together with the cleaning solution, loosens and collects dust and dirt from entire depth of record grooves. Special feature is the rotating handle which permits a fresh cleaning surface to be provided continually as the cleaner is moved across the record.

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Circle 63 on reader service card

Circle 33 on reader service card

SOLID-TUBE, R-3DS3. Silicon solid-state plug-in rectifier tube replaces vacuum tube rectifier types 3DR3 and 3DS3. Emits no Xradiation, creates no heat and since it has



no filament, it makes an ideal substitute in cases where the filament or flyback transformer is faulty.-Electronic Devices, Inc., 21 Gray Oaks Avenue, Yonkers, NY 10710.

Circle 34 on reader service card

CASSETTE DECK, model CD-1669. ANRS-Automatic Noise Reduction System-reduces tape hiss to an inaudible level without af-



fecting the quality of the music. Accommodates tapes recorded with other noisereduction systems. Has automatic ANRS

Features include Super Cronios ferrite heads for longer life, two tape-select switches for bias and equalization, solenoid operated controls. Hysteresis synchronous motor drives the capstan and a dc motor drives the reels for accurate speed and decreased wow and flutter. Indicator lights show deck's function and peak-level indicator flashes a warning when over-recording takes place. Auto stop and auto play rewinds and restarts the deck automatically. There is independent input select switch for improved linearity. \$499.95—JVC America, Inc., 50-35 56th Road, Maspeth, NY 11378.

Circle 35 on reader service card

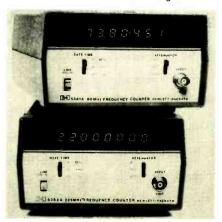
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Circle 36 on reader service card

ELECTRONIC COUNTERS, 5381A and 5382A. Lab-quality counter makes possible precise alignment of the crystal filters and high-Q i.f. strips found in costly stereo receivers, assuring they will operate in the home the way they did in the design lab. Similar satisfactions can be found from setting the SCA



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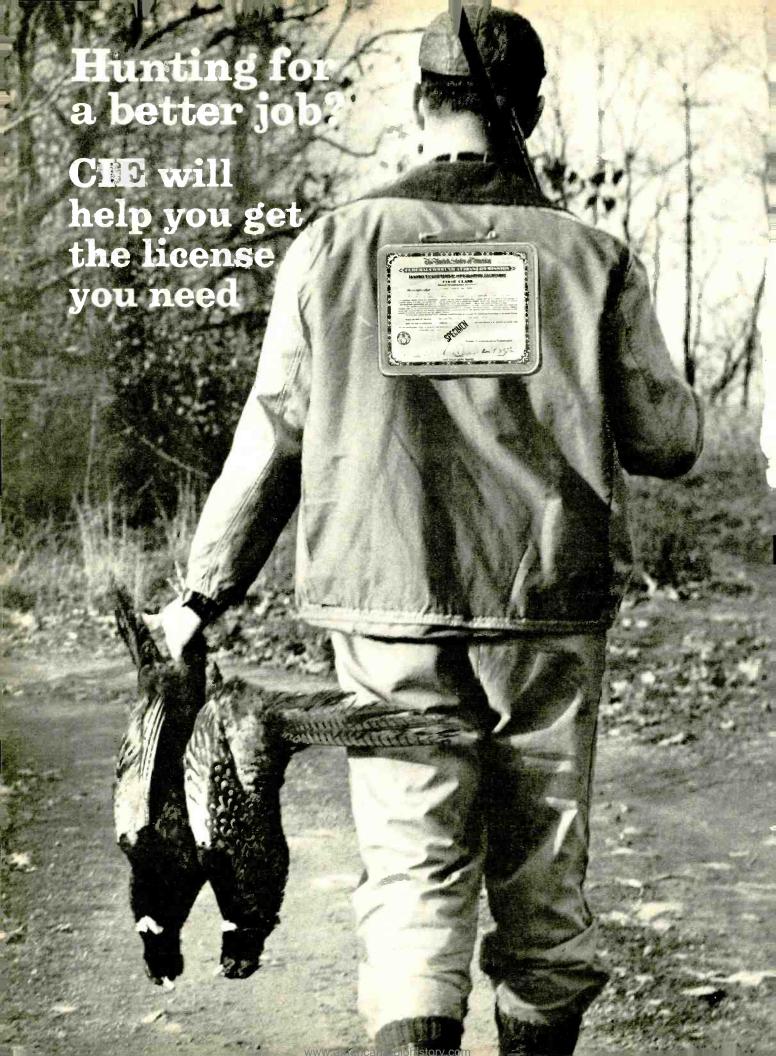
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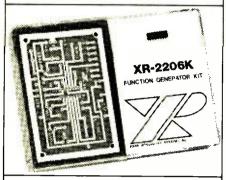
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Circle 69 on reader service card

TV TYPEWRITER II

(continued from page 63)

plugs and note that each of the connectors is indexed to allow them to be plugged in only one way. J10 and J11. however, are physically the same type of connector so use a felt tipped pen to mark one of the two sets to prevent yourself from inserting one of the plugs into the wrong jack. Try to keep all of the wires in the connector harnesses as short as possible and be sure the ground and +5v wires between the power supply and the main board are 18 gauge or heavier.

The power supply must be capable of supplying 5 Vdc, 2A at 5% regulation or better; -12 Vdc, 200 mA; and -5 Vdc, 15 mA. You can either build your own from scratch or purchase one from the source supplying the TV typewriter kits. You must make absolutely sure all of the power leads are wired correctly to the connector; otherwise you can cause a lot of damage when the power is applied.

Now its time to get out the television or monitor you plan to use. Although the actual modifications necessary will vary from set to set, the modifications shown will probably be satisfactory for most small screen transistor portables. The TV typewriter's output must be connected to the input of the television's video amplifier, which is located between the last video i.f. stage and the video output circuit. When you break the circuit right at the input to the video amplifier, you will probably have to provide a dc bias circuit for the stage since in most cases it is supplied by the now disconnected video i.f. amplifier. The circuit in Fig. 2 is for the Motorola 9TS-469 Q set used with the prototype. A switch and BNC connector were provided to allow either TV typewriter or normal television viewing.

A dc restoration circuit was also added to keep the screen intensity from changing as a function of the density of dots displayed.

Check the power supply to be sure the voltages are OK and that wiring to the connector is correct. Go back now to the main PC board and wire in the correct keyboard jumper. If your keyboard has a positive "keypress strobe" pulse, wire terminal 3 to terminal 1, and if it has a negative "keypress strobe" pulse, wire terminal 3 to terminal 2. These pads are just adjacent IC32 and are numbered on the top side of the board. If the keyboard has a 1 microsecond or less strobe pulse, either of the two positions will work properly.

Plug the "memory" board onto the main board using the set of connectors marked "memory." Be sure the top

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Connect the power supply, keyboard and television to the main board and after making a final check for errors, apply power. If you haven't made any mistakes and have a little luck, the unit will work first off. The only adjustments are the oscillator frequency adjustment pot, R38, the left margin control, R4 and the horizontal character size control, R6. The phaselocked oscillator should lock in over most of the range of the control R38, but may vary from unit to unit. An out of lock condition will be indicated by a slight vertical roll and a litterey character presentation. The other two controls should be set to give the best

If the unit doesn't work, first check the power supply voltages to make sure they are OK and then use an oscilloscope to see whether or not there is a video output signal. If not, start checking from the phase-locked oscillator with your scope and try to locate the problem from there.

If you don't have any problems and everything seems to work correctly then go ahead and connect up the control switches. For maximum flexability the page-select switch, available at jack J10, should be a spdt center off switch; (continued on page 90)

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COSMOS BURGLAR ALARMS

(continued from page 35)

tion. Under this condition, the relay is de-energized and the alarm generator is off. The circuit consumes a typical standby current of 1-µA. The alarm can be activated by opening any one of series-connected sensor switches S3 or by closing any one of parallelconnected sensor switches S2. Under this condition, a positive-going transition appears on pin 2 of the monostable and its output switches into the high mode for a pre-set period and drives transistor O1 into conduction, thus energizing the relay and turning the alarm generator on. At the end of this period, the output of the monostable goes low again, independent of the states of S2 and S3, and the alarm generator turns back off. The circuit can then be reset either by opening and then closing S1 or by setting all S2 and S3 switches back to their original positions.

Note in the Projects 3 and 4 circuits, that power is permanently applied to the Q1-RY1 components, even when S1 is in the off position. This enables the alarm to be activated in the nonlatching mode at all times via a normally open temperature-sensing switch such as a thermostat, so that these circuits can also function as a permanently alert fire alarm system. Any number of normally open switches can be wired in parallel with S4.

A weakness of the Projects 3 and 4 circuits is that they give the owner no protection against intruders who may break into the house in daylight hours when the main alarm system is switched off. Protection against this type of intrusion can be obtained by scattering a number of series-connected normally closed 'panic' buttons around the house, so that a permanently-alert self-latching alarm system can be activated at any time. This facility can readily be added to the Projects 3 and 4 circuits. Project 5 shows how it can be wired into the auto-turn-off system of Project 4.

In Project 5, part of IC2 is wired as a simple bistable multivibrator circuit that is permanently connected to the supply lines. The output of the bistable is connected to the base of transistor Q1, via diode D2 and resistor R10, so that Q1, the relay and alarm generator can be turned on via the bistable. Diode D1 is wired in series with R5 of the main alarm system so that the two sections of the circuit do not interact adversely. The output of the bistable is normally latched into the low state, so the relay and alarm generator are normally off. If any of series-connected panic buttons S5 are momentarily opened, the bistable im-

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mediately changes state and its output locks into the high state and drives relay RY1 and the alarm generator on. Once the alarm generator has been turned on, it can be reset to the OFF state by closing RESET switch S6.

This panic facility can be added to the Project 3 circuit by simply wiring diode D1 in series with R5, and adding IC2 and its associated circuitry.

Other points to note about the Project 3 through Project 5 circuits are as follows:

1. The relay used in each circuit can be any 12-volt type with a coil resistance of 180 ohms or greater, and with one or more sets of n.o. contacts.

2. Timing capacitor C2 of the Projects 3 through 5 circuits must have a reasonably low leakage resistance, otherwise the alarms may fail to turn off at the end of their pre-set periods. The best way to find out if the capacitor is suitable is to simply put it in the circuit and check that it works OK under operating conditions.

3. The three circuits can drive any types of alarm generators (bells, sirens, electronic generators, etc.) via the relay contacts RY1-1. Note, however, that these alarm generators must be operated from their own power supplies, otherwise they may interfere with the electronic functioning of the actual systems. (continued next month)

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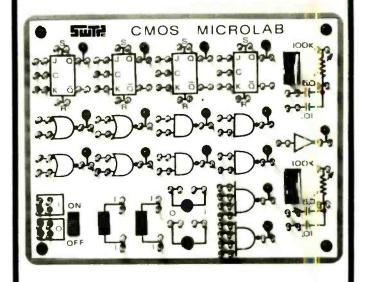
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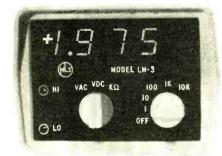
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TV TYPEWRITER II

(continued from page 87)

then when either of the two pages are selected, the cursor will always remain on the same page even when the end of frame is reached. In the center position, the cursor will alternately jump from one page to the other as the end of frame is reached. As with all of the other switch connections to follow, the inputs are all tied high with pull up resistors so all switching should be done by grounding the appropriate terminal.

The cursor on/off terminal, available on jack J10, if left unconnected will always cause the cursor to blink in the next character position to be typed. However, the blinking cursor may be turned off at any time by grounding the "CURSOR ON/OFF" pin on jack J10.

For maximum manual cursor control, the optional cursor control board should be used, however, the home-up (move cursor to upper left hand corner), erase to end of line (EOL) and erase to end of frame (EOF) are available at the pins to be used for the cursor control board. Temporarily grounding pin 10 of IC9-b will generate an erase of end of line, and temporarily grounding pin 4 of IC2-a will generate and erase to end of frame and grounding pin 12 of IC32-d will force a "home up."



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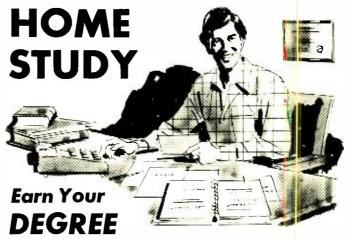
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This is a valuable source of information for anyone concerned with transistor replacement, industrial, commercial or home-entertainment devices.

TV BENCH SERVICING TECHNIQUES, by Art Margolis. TAB Books, Blue Ridge Summit, PA 17214. 227 pp. $8\frac{1}{2}$ x $5\frac{1}{4}$ in. Hardcover \$7.95; Softcover \$4.95.

The text explains the setup of a typical efficient shop, outlines shop repair methods and provides troubleshooting procedures for each section of color and black & white receivers.

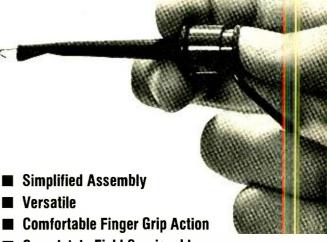
Assuming only a basic knowledge of electronics on the part of the reader, the book examines the basic operation of tube-type, solid-state and modular receivers and tells how to cope with the fundamental inherent characteristics of each type—from a troubleshooting standpoint. Also included are detailed instructions for picture-tube tests and repairs and color setup adjustments, including purity, convergence and high voltage.

THE COMPLETE SHORT-WAVE LISTENER'S HANDBOOK, by Hank Bennett. TAB Books, Blue Ridge Summit, PA 17214. 288 pp. $8\frac{1}{2}$ x $5\frac{1}{4}$ in. Hardcover \$9.95; Softcover \$6.95.

For those persons searching for an extremely interesting and exciting hobby, this handbook will introduce them to short-wave listening. It is very easy to read and understand, even for those who know nothing about electronics or the art of tuning in distant stations.

This book is designed to acquaint the reader with the basics of the SWL hobby. It covers receivers, antennas, frequencies, radio-wave propagation, harmonics, Q codes, where to tune for various type signals, how to keep a log book and how to prepare and send reception reports. It contains a thorough guide to stations of the world by general continental area and frequency.

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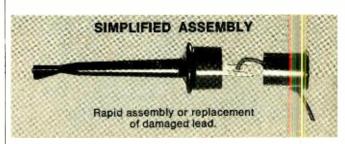
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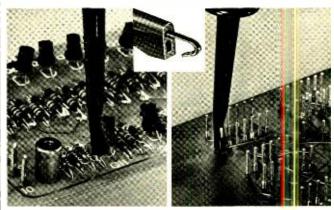
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CLINIC QUESTIONS

(continued from page 76)

DELAYED INSTANT-ON

The sound comes on instantly, in this RCA CTC-62. Owner says that the picture used to come on instantly, too. Now, it takes from 20 to 30 seconds to light up. Plays perfectly after it comes on. Only thing wrong is that it won't "Instant-On" any more. I'm lost.—G.C., Shreveport, La.

If the set works perfectly after it does light up, it's OK. In this chassis, the horizontal oscillator is left on, at reduced voltage, all the time. (See circuit in **Radio-Electronics** Dec. 1973, page 38.) The INSTANT-ON switch does not turn the dc voltage supply off, but it apparently "turns it down." The OFF-ON switch, in ON position, connects the ground side of the ac line to ground. The hot side stays connected at all times.

IN OFF position, the ground side of the ac line goes to ground through the degaussing coil and a thermistor, and a 2.7-ohm resistor. Since nothing is wrong but the Instant-On, this circuit must be open. Degaussing coil unplugged, etc.

INTERMITTENT FUSE-BLOWING

The 6146 tube plates get red hot and the fuse blows, in this high-powered RCA amplifier. It's used in a PA/communication system. No dead shorts, no shorted tubes. Any suggestions will be very welcome! It's intermittent!—W.J.M., Phoenix, Ariz.

Most likely cause for the kind of intermittent fuse-blowing you've got here would be intermittent failure of the bias supply for the 6146 output tubes. This is a fixed bias, coming from a tap on the power transformer secondary, through a diode restifier and filter, and probably through a variable resistor for adjustment. You could have an intermittent filter capacitor, a wire-short to ground, or something like that. Look for possible shorts where the bias lead crosses sharp metal edges; I had one of those not too long ago.

PALE PICTURE, POOR AGC

I've got a very pale picture, and odd agc action on this Truetone 2DC3916. No snow on the screen without antenna. I subbed the tuner; no help. I.f. tubes check OK. Voltages good. What's doing this?—M.D.O., Mena, Ark.

Pull the 8JV8 video output tube. Read the resistance from the control grid to ground. Reverse the ohmmeter prods. You should have a fairly low resistance; 150 ohms or so, one way and a high resistance, 3000 ohms or more, the other. If you read about 10 ohms one way and 30 ohms the other, the video detector diode is leaking. This is inside the last i.f. can, and it's not easy to get at. Use one of the small glass 1N60's; nothing else will fit.

HV REGULATION

I can't adjust the high voltage, on this Zenith, 6Z8C50 chassis. Here are the voltages I got around the 6HV5 high-voltage regulator. What do you think it is?—O.W., Hatfield, Ark.

I think your regulator isn't regulating! Note that grid voltage. You have +200 volts, and you ought to have +350. The cathode voltage is OK, at +390. So, the regulator grid is about 150 volts farther negative than it should be. This tube is cut off completely; it isn't conducting. Check some resistors, and possibly that VDR. One of them must be away off value.

SLOW FOCUS?

It takes about 5 minutes for this RCA CTC-15 to come into focus. This isn't normal, is it?—A.G., Oakland, N.J.

Nope. My CTC-15 comes on, focused, in 30 seconds. You have one of two possibilities; either the focus or the high voltage is a little slow warming up. Focus voltage must be a percentage (about 20%) of the high voltage at any given time. Read both focus voltage and the high voltage at turnon, and you'll know where to look.

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BUILD A TICK TIMER

(continued from page 41)

over-tighten the mounting screws and make certain there are no sharp ends of the screen wire extending inwardly, to poke through the speaker cone. Locate the board assembly with its potentiometers toward the side of the cabinet, rather than toward the center, to make them easily accessible. Be sure there is sufficient clearance to prevent short-circuiting the potentiometer bodies to the metal cabinet, when the back/sides part is slipped into place.

Calibration

When the unit has been completely assembled, and checked for possible errors, turn switch S1 to OFF and install the battery. An ordinary transistor battery will suffice for casual operation of the timer, but if you contemplate using it often or for long periods, an alkaline battery such as the Mallory MN1604B, will give better service.

Set potentiometers R1 and R6 at maximum resistance in the circuit. Set potentiometer R4 at about mid-position, and potentiometer R8 at the grounded end of its rotation. Turn switch S1 to on, and after a brief pause, ticks should be heard from the speaker. There will be no accented ticks,

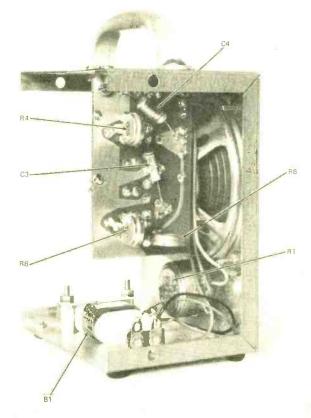


FIG. 3—COMPONENT LAYOUT from foll side of circuit board.

since this part of the setup has been momentarily disabled by the pre-setting of R8. Adjust potentiometer R1, the front-panel control, until the ticks occur at exactly one tick per second.

With R1 properly set, rotate R4 to the grounded end of its rotation and advance R8 to about mid-position. Now the 1-second ticks will not be heard. Adjust potentiometer R6, the 10-second rate control, to where a tick is heard from the speaker once every 12 to 13 seconds. The extra 2 to 3 seconds makes this generator run slowly enough to enable it to be synchronized with the pulses from the 1second generator.

With R6 adjusted as described, turn the timer off and solder capacitor C3 in place. Switch the timer on again, and

NOUSTRIES

advance potentiometer R4 to where the 1-second ticks are heard from the speaker. If you've been fortunate, every 10th tick will be louder. You may find, however, that every 9th or every 11th tick is being emphasized. If you're getting 9-second intervals, advance R6 slightly, to put a little more resistance in the circuit, and recheck performance. On the other hand, if you're getting 11-second intervals, R6 should be adjusted to put a little less resistance in the circuit. With R6 set as previously described, very little readjustment should be needed.

Adjust potentiometer R4 to where the 1-second ticks are heard distinctly but not too loudly. Then adjust R8 to where every 10th tick is obviously emphasized. Put the back/sides cover in place. The timer is now ready for use.

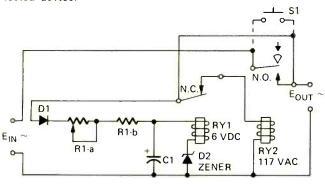
In using the instrument, it will be noted that the first louder tick, after the unit is switched on each time, is always later than normal. In my setup, the first emphasized tick occurs at 14 seconds. All lounder ticks after the first one will be at the required 10-second intervals.

OVERVOLTAGE RELAY

Vacuum-tube handbooks point out that 10% overvoltage cuts tube heater life in half. Cathode-ray tubes in oscilloscopes and TV receivers are expensive, often indispensable and—in some areas—replacements are not readily available. This overvoltage relay circuit was developed to protect voltage-sensitive devices by interrupting the power when the line voltage rises only a few volts above normal.

The $V_{\rm r}$ rating of Zener diode D2 is chosen by trial and is below the normal rms supply voltage by a little more than the dc operating voltage of RY1. Diodes D1 and D2 carry the coil current of RY1. D1 should have a PIV rating greater than the peak ac voltage (2.8 $E_{\rm rms}$ if $E_{\rm tm}$ is a sine wave). Electrolytic capacitor C1 is made large enough so RY1 does not chatter. The total resistance of R1 is chosen so $V_{\rm r}$ —the voltage across C1—approximates the rms voltage, not the peak voltage, R1-a is a pot or adjustable resistor for fine adjustment of the tripping voltage.

To energize the device protected by this overvoltage relay, close RY2's contacts manually or by pressing an optional momentary switch (S1) connected across the relay contacts. If the supply voltage is normal, RY2 will remain energized through the normally closed contacts of RY1. If the line voltage is too high, RY1 is energized so the RY2 contacts open to prevent power from flowing to the protected device.



When adjusted for a 115-volt, 60-Hz normal supply; with RY1 rated at 6 volts dc and V_z selected as 100 volts, the overvoltage protector consistently shuts off at 120 volts without false triggering. The span between the normal and tripping voltages can probably be made smaller by selecting RY1 for a lower operating voltage.

R1 and C1 and the current ratings of D1 and D2 depend on the coil voltage and current of RY1. The greater the sensitivity of RY1, the lower the power wasted in the protector circuit. Diode D1 should have a PIV rating of 300 volts or more.—A.H. Taylor

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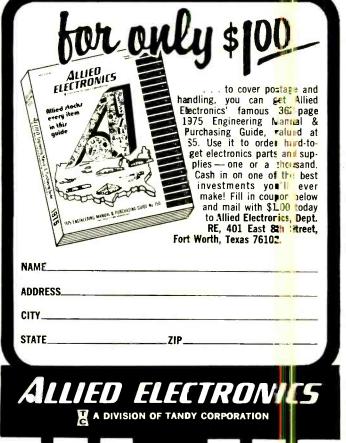
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220 pf/500V 7c	5.5c	4.5c	3.6c	14 pin Solder. 29c	23c
470 pf/500V 7c	5.5c	4.5c	3.6c	16 pin Solder . 32c	25c
,001/500V7c	5.5c	4.5c	3.6c	18 pin Solder, 34c	26c
.0022/500V 7c	5.5c	4.5c	3.6c	24 pin Solder, 54c	42c
.0047/500V 7c	5.5c	4.5c	3.6c	1	10
.01/500V 10c	7.5c	6.3c	5.0c	8 pin W.W 38c	30c
.01/25V 5c	3.5c	3.0c	2.46		
.022/25V 6c	4.0c	3.5c	2.7c	14 pin W.W 50c	39c
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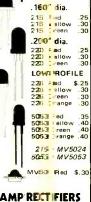
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1403AH	8.00	2512K	5.50
1403AN	5.40	2521V	4.00
1404AH	8.00	2524V	3.90
1404AN	5.40	2525V	5.30
1405A	4.10	2533V	8.50
1506	4.00	3341PC	8.20
1507	4.00	MM5025N	20.00
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C2102	8.00	MM5055N	5.50
P2102	6.00	MM5056N	5.50
C2102-1	8.00	MM5057N	5.50
P2102-1	6.00	MM5058N	5.50

	MOS	-LSI	
P1101A	6.90	C2102-2	8.00
P1101A1	8.50	P2102-2	6.00
1402AN	5.40	2505K	3.30
1403AH	8.00	2512K	5.50
1403AN	5.40	2521V	4.00
1404AH	8.00	2524V	3.90
1404AN	5.40	2525V	5.30
1405A	4.10	2533V	8.50
1506	4.00	3341PC	8.20
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C2102	8.00	MM5055N	5.50
P2102	6.00	MM5056N	5.50
C2102-1	8.00	MM5057N	5.50
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	MOS	-LSI	
P1101A	6.90	C2102-2	8.00
P1101A1	8.50	P2102-2	6.00
1402AN	5.40	2505K	3.30
1403AH	8.00	2512K	5.50
1403AN	5.40	2521V	4.00
1404AH	8.00	2524V	3.90
1404AN	5.40	2525V	5.30
1405A	4.10	2533V	8.50
1506	4.00	3341PC	8.20
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P2102	6.00	MM5056N	5.50
C2102-1	8.00	MM5057N	5.50
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1402AN	5.40	2505K	3.30
1403AH	8.00	2512K	5.50
1403AN	5.40	2521V	4.00
1404AH	8.00	2524V	3.90
1404AN	5.40	2525V	5.30
1405A	4.10	2533V	8.50
1506	4.00	3341PC	8.20
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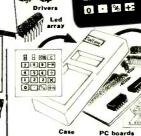
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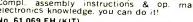
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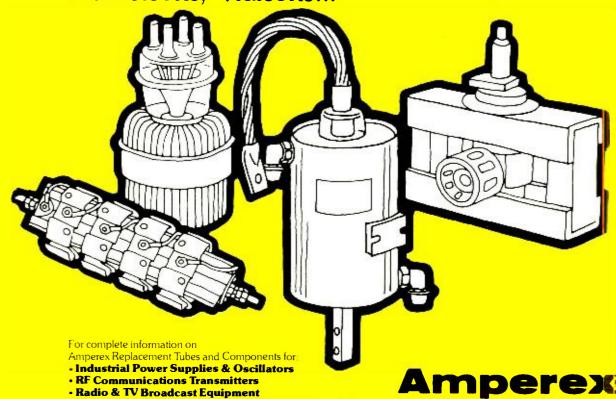
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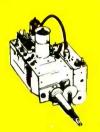
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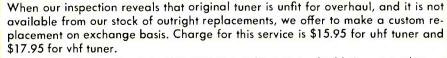


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