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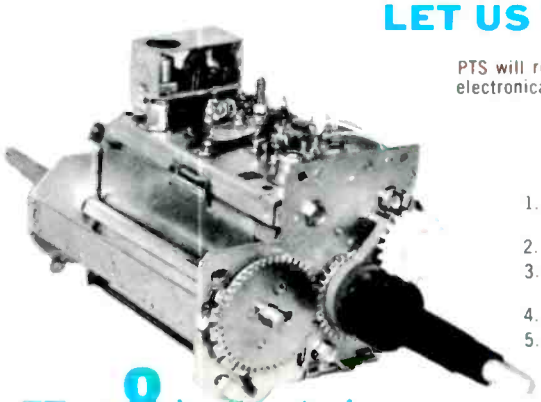

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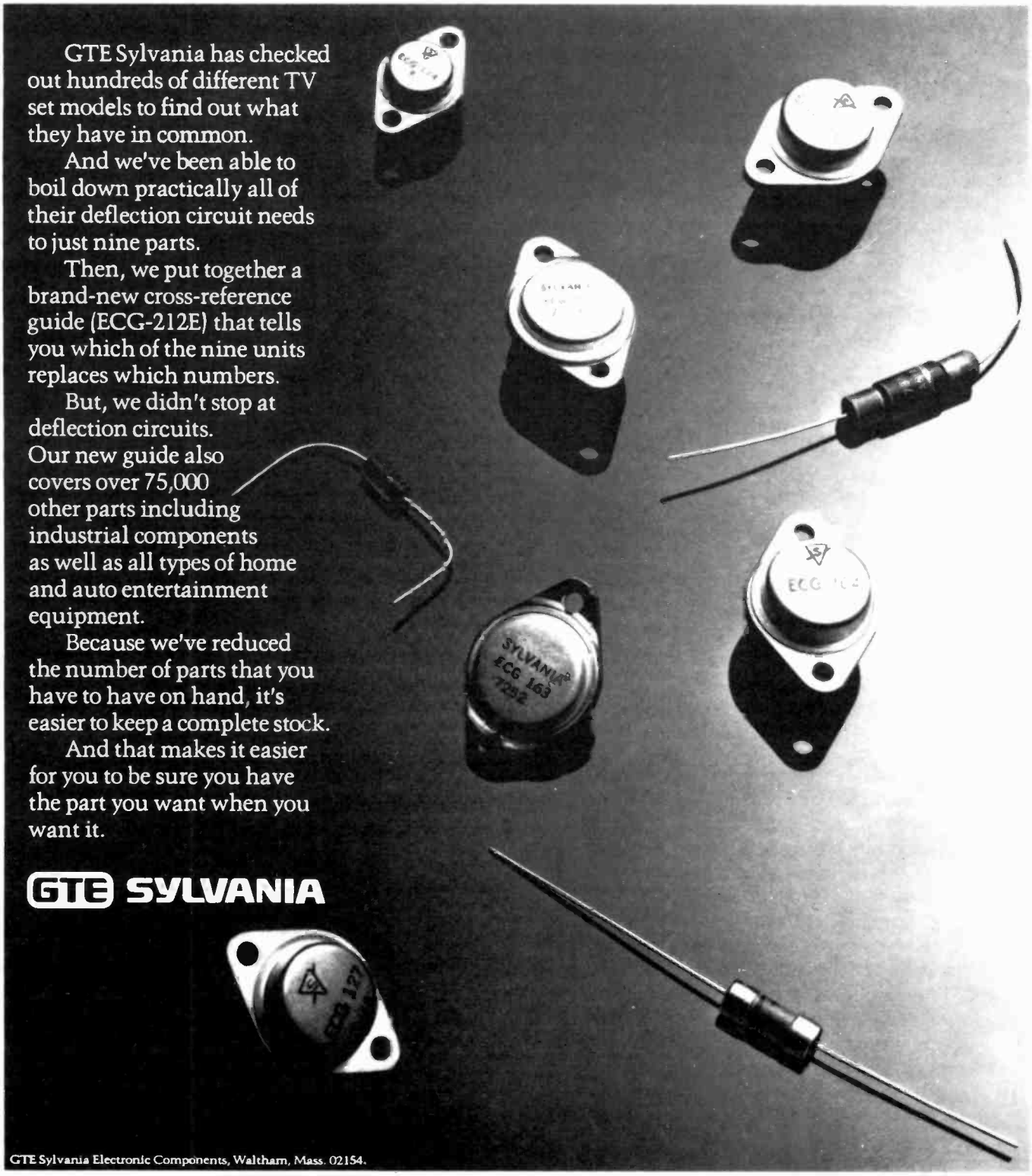

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NOVEMBER 1974 Vol. 45 No. 11

ON THE COVER

This complete computer terminal is equipped to operate over phone lines and has an output you can connect a tape recorder to. Best of all, you build it from a kit. Get all the details in the article starting on page 42.

DIGITAL MULTIMETERS UNDER $300? There's a heap of them. Here's a wrapup showing what's available and what they will do. **. . . see page 45**

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looking ahead

Flat TV screen

The long quest for a thin-panel electroluminescent TV screen as a substitute for the cathode ray tube may be nearly over, according to scientists at Japan's Sharp Corp. They claim to have overcome the drawbacks in previous devices—short life and low brightness. Lab samples of Sharp's thin-film panels have been operated for 10,000 hours "without any indication of degradation" and with brightness of more than 60 foot-lamberts at the regular 60-fields-per-second TV scanning rate. Contrast ratio was given as better than 60 to 1.

Sharp's panel, said to be about the thickness of a windowpane, is a three-layer sandwich (electroluminescent layer between two insulating layers) and is driven at a peak voltage of 260 volts ac. The experimental unit is 48 x 36 mm (about 1.9 x 1.4 in.), has 81 picture elements vertically, 108 horizontally, and is addressed by horizontal and vertical grids. Sharp says production is now feasible and the initial applications probably will be for calcuator and computer display, rather than TV. The device currently is monochrome (orange-yellow), but Sharp is working on a three-color version. Sharp officials are so confident they're on the right track that they predict the first no-tube television set within "the next few years."

Digital watches

The electronic digital watch soon will be the hottest new product on the market, and there are indications that prices will decline as rapidly as those of electronic calculators. Until very recently, LED and liquid-crystal types were selling at $250 and up. During the summer, new models came out in the $200 range, followed shortly by watches as cheap as $120. Next step: $85. Timex is now marketing a liquid-crystal quartz wristwatch at that price. Not only are the traditional watch manufacturers in the race, but the calculator manufacturers—such as Bowmar, Casio and Eiko—are joining in, and before long the makers of IC's are expected to enter the market with their own brand watches, just as they did in the calculator field.

Calculators, meanwhile, are glutting the market. With an oversupply, the calculator industry underwent a severe recession last summer and was counting on the student and Christmas markets to help pull them out. Despite inflation, prices continued to drift downwards, with under-$20 units no longer unusual and an occasional bargain showing up at less than $15.

Audio price probe

Is there illegal price-fixing in the audio components business? Spurred by complaints from dealers, the Federal Trade Commission has launched a nationwide investigation to determine whether brand-name manufacturers and importers are withholding merchandise illegally from dealers who sell below specified minimum prices. The FTC revealed no details of its inquiry, but it's believed to cover not only the traditional audio retailers but mail-order houses which advertise in audio publications and various other discount operations, such as those in large cities which quote discount prices by telephone.

Solid-state sweeps TV

It probably won't come as any surprise that solid-state circuitry is finally overtaking the television industry. In the first half of 1974, nearly 63% of all color sets produced or imported into the United States were solid-state models, as compared to only 36.5% in the first half of 1973. In the 1974 period, more than 83% of all consoles and 54.5% of all portables and table models were solid-state, but solid-state construction accounted for only a little more than 30% of monochrome sets.

Portables and table models continued to increase their share of the color TV market, representing 71% of all sets in the 1974 period, up from 66% in the first half of 1973. The fastest growing picture tube sizes were the new 13-, 15- and 17-inch categories, at the expense of the 12-inch-and-under and the 25-inch sizes. Remote control may be coming into its own, accounting for a record 8.2% of color sets in January-June 1974, up from 4.6% in the same 1973 period.

In black-and-white, the 11- and 12-inch sizes represented more than one half of the total supply for the first time (it was less than 40% one year earlier), and the monochrome console finally has virtually disappeared, dropping to only 2% of the total.

Tighter UHF rules?

After 22 years of UHF broadcasting, there is a strong feeling among engineers on the FCC staff that new measures are necessary to bring a greater level of equality between UHF and VHF television stations. These could take the form of new regulations aimed at better performance of UHF transmitters or receivers or both. Recent FCC tests of receivers indicate that the performance level of UHF tuners has improved little, if at all, in two decades. The Public Broadcasting System is beginning a series of tests of both transmitters and receivers which could result in recommendations to the FCC for further action to mandate UHF-VHF parity. The all-channel law already resulted in bringing the UHF receiver population close to 100% of TV households. The more recent tuner-parity rules make UHF as simple to tune as VHF in current-model receivers—if the viewer can locate the UHF signals at all.

Some sentiment is discernable at the FCC for an amendment to the all-channel law to give the Commission the authority to establish UHF tuner performance standards. The FCC currently has the power to fix noise levels only—and it's felt that congressional action would be required to give it greater authority over other performance factors. So far there's no groundswell for further action on UHF, but it could build up in the coming months.

$31.6 billion for electronics

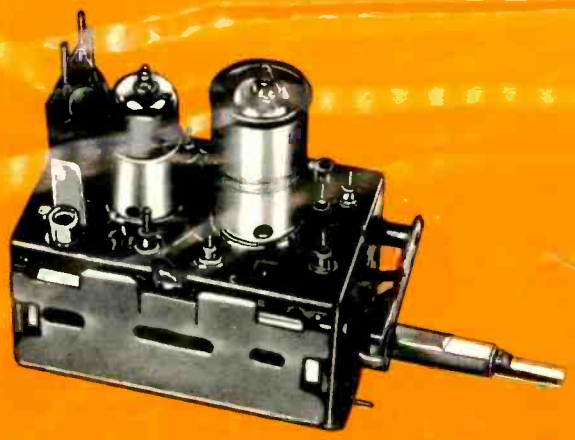
The U.S. electronics industry brought in $31.6 billion in factory sales last year, according to EIA. The biggest segment was the communications and industrial market, which accounted for $12.9 billion, followed by government electronics (military, space, etc.) at $10.8 billion. The consumer market accounted for sales of $6.9 billion, while replacement parts represented $920 million in sales. All segments of the market registered increases in 1973, and total electronics business was up 7.4% from $29.5 billion in 1973.

The other matrix

Although most of the publicity in the four-channel record race has gone to the discrete CD-4 (Quadradisc) and SQ matrix systems, another matrix system is now making a major bid. This is the QS system, being pushed by Sansui.

Sansui's catchword is Vario-Matrix, which describes a new four-chip decoder circuit that has a three-position switch—for decoding QS discs, SQ discs and synthesizing four-channel from regular stereo records.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR



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new & timely

Active Citizens Bander is named "Handicapped American of Year"

H. Keith Russell, Silver Spring, MD, a member of the Montgomery County REACT No. 2348, has been named Handicapped American of the Year by the President's Committee on Employment of the Handicapped, and was awarded the President's Trophy, the nation's highest honor to its handicapped citizens. (REACT—Radio Emergency Associated Radio Teams—is an organization of Citizens Band groups who keep a 24-hour watch on CB channel 9, give help to motorists in difficulties and assist in emergencies and catastrophes.)

Mr. Russell, who moves about with crutches and long leg braces, works continuously for handicapped people—especially in the area of removal of architectural barriers— in addition to his REACT volunteer work. In Montgomery County he was instrumental in helping the passage of special parking privileges for the handicapped, ramping of shopping centers, curb-ramping ordi-

H. Keith Russell

nances, and the removal of discriminatory employment practices.

He is also active in local and national organizations concerned with the removal of such architectural barriers as stairs, narrow doorways, etc., which prevent 10% of the population from moving about freely.

Mr. Russell is chief of the Armed Forces Institute of Pathology Histopath Laboratory of Walter Reed Hospital and has an additional part-time occupation as a musician. He also builds musical instruments and installs automobile hand-controls for a large manufacturer. In addition, he often travels to speak to medical groups about the correct use of medical aids for severely handicapped patients.

Duval Payne and David Robinson win latest Gernsback Award

Duval W. Payne, a home-study student of the National Technical Schools, Los Angeles, is the most recent winner of the 1974 Hugo Gernsback Scholarship Award, a check for $125 given annually to a student in each of eight leading

Duval W. Payne

electronics home-study schools. The Award is in memory of the late Hugo Gernsback, who devoted much of his energy to encouraging young men in the study of electronics.

David B. Robinson

A second prize—an RCA WV-529-A "Service Special" VOM—contributed by RCA for the runner-up in each of the 1974 Award contests, goes to NTS student David B. Robinson.

Mr. Payne, who lives in Pittsburgh, writes: "I am employed at present as foreman of Building Equipment Maintenance for the U.S. Postal Service, which has become so highly automated that they have need for technicians. . . . The things I have learned are a tremendous asset on my present job, and I also intend doing part-time TV repair."

Mr. Robinson is an auto mechanic, shop foreman for Daniels Chevrolet in Colorado Springs, CO. He says: "The knowledge gained (in my current Electronics course with NTS) has been of extreme importance in the presently expanding use of electronics in cars. In coming years, I think courses like this should be included in expanded Auto Mechanics courses."

Radio waves may affect human health

Radio waves may affect the nervous system and behavior, and normal development and growth processes "at lower levels than anticipated in the past," the government Office of Telecommunications Policy stated in a report to Congress. The Office warns, however, that the tentative findings are based on a small number of experiments on a limited number of subjects, and that "casual relationships between the electromagnetic fields and observations are not yet clearly established."

High concentrations of radio frequency radiation is known to cause adverse biological effects by generating heat in the tissues. The thermal effects are fairly well understood, and it has been fairly well established that power densities of less than 10 mW per cm^2 are harmless to human beings, as far as their heating effects are concerned.

Less is known of other effects of rf radiation, though they have been suspected to exist for some time, especially with microwaves. In the 1940's, while he was manufacturing microwave diathermy equipment, Lee de Forest suggested a study of "the non-thermal effects of higher radio frequencies." Some effects of radio waves are rather sharply tuned: ants align their antennas parallel to an electromagnetic field at 9 MHz; emissions at 29-MHz have been used to kill bugs in bread, and radiations at 388-MHz have killed monkeys. On the other hand radiation at 21-MHz increases the germination of gladiolus bulbs. These are obviously non-thermal phenomena; effects due to heat would cover wide frequency bands.

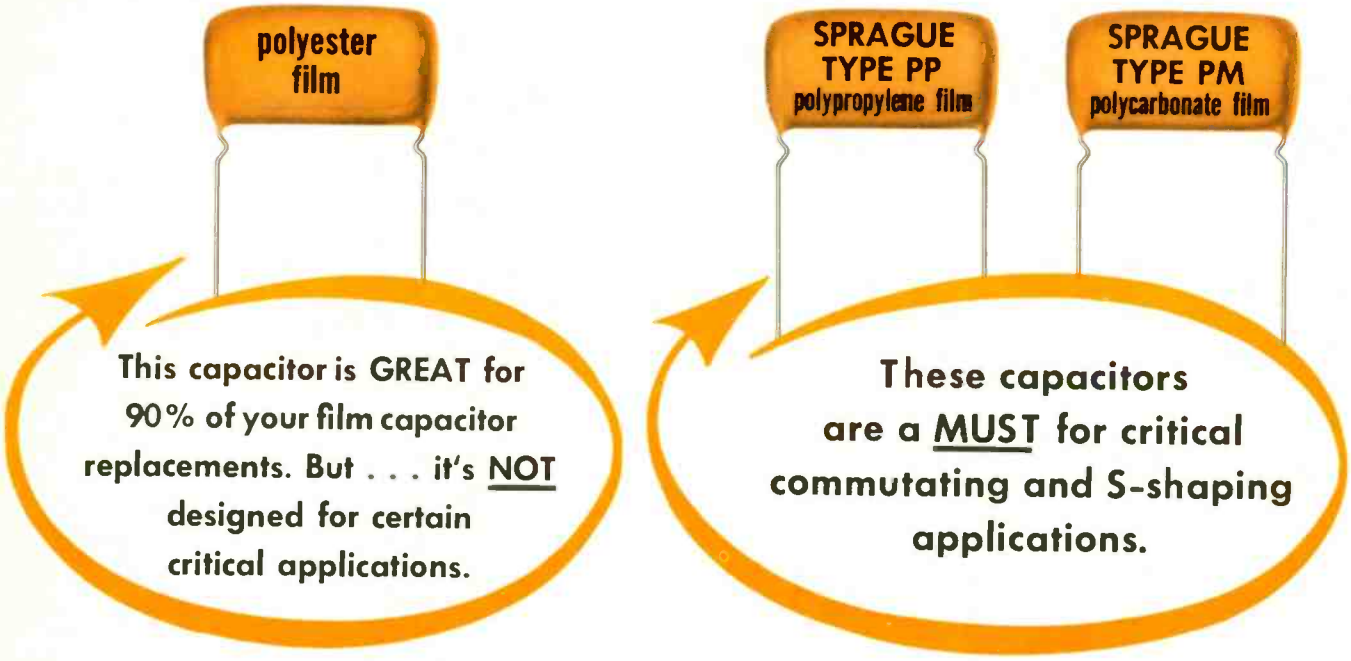
Emergency audio transmitter is help for seizure victims

A device for persons who may be liable to heart attacks, epileptic seizure or diabetic coma is now being marketed by a Denver firm.

Called the Emergency Medical Instructor, it is a small case that contains a taped message pre-recorded by the patient's own physician, telling what is

(continued on page 12)

Avoid serious trouble in color TV sets by using the right replacement capacitor!



The next time you replace a dipped tubular in one of the newer color TV sets, don't automatically assume you're replacing an ordinary every-day film or paper capacitor. If it happens to be a deflection capacitor used for commutating or S-shaping, you need a polypropylene or polycarbonate film replacement with (1) high a-c current-carrying capability; (2) close capacitance tolerance; (3) good capacitance stability. The standard replacement capacitors used in the industry, even our superior Type PS dipped tubulars, just won't do the job . . . and they could cause serious trouble after the set is put back into operation.

Play it safe . . . dipped tubulars may look alike on the surface, but there can be a big difference in the film dielectric. Keep a supply of Sprague Type PP and PM capacitors on hand for those critical situations where ordinary replacements won't work.

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.2 @ 400	±5%	.700 x 1.700	PP4-P20
.0018 @ 600	±5%	.400 x .750	PP6-D18S
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.0039 @ 600	±5%	.400 x .800	PP6-D39S
.01 @ 600	±5%	.500 x 1.250	PP6-S10S
.066 @ 600	±5%	.800 x 1.250	PP6-S66S
.075 @ 600	±5%	.750 x 1.250	PPS-S75S
.022 @ 800	±3%	.600 x 1.300	PP8-S22S
.047 @ 800	±5%	.700 x 1.250	PP8-S47S
.051 @ 800	±5%	.800 x 1.250	PP8-S51S
.0018 @ 1600	±5%	.500 x 1.300	PP16-D18
.002 @ 1600	±5%	.500 x 1.300	PP16-D20
.0033 @ 1600	±5%	.550 x 1.300	PP16-D33
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For cross-reference information on close-tolerance polypropylene and polycarbonate film capacitors, showing original part numbers with correct Sprague replacements, ask your Sprague distributor for Cross-Reference Guide C-873, or write to: Sprague Products Company, 81 Marshall Street, North Adams, Mass. 01247.

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*Summary of survey results upon request.

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new & timely (continued from page 6)

happening, the identity of the victim, and giving necessary instructions for emergency action. If the wearer falls to the ground, the device starts and continues to repeat the 4-minute message loud enough to attract attention, for up to two hours.

The manufacturer, National Identification Co., believes the equipment will save lives, since in the past some such cases have been mistaken for ordinary drunkenness and correct treatment delayed until too late.

Microneurosurgery is aided by compact color TV

Microneurosurgery—operation under a microscope—has been hampered by the fact that no more than two persons can watch the operation. Using extremely small surgical instruments, one surgeon operates looking through a binocular microscope while the other viewer uses the second lens of the binocular. This not only limits the possibility of training other surgeons, but places the surgeon in an isolated position, as the operating room staff are unable to observe the operation and therefore cannot intelligently anticipate the surgeon's needs.

With the help of a new compact color TV camera, devised by Motorola, New York's Mount Sinai hospital has overcome these difficulties. Since the size of the new camera permits connecting it directly to the microscope, the operation can be telecast to TV sets in the operating room exactly as the surgeon sees it. The operation can also be recorded on videotape as an aid in training future surgeons for the same operation.

Auto license plate to go electronic?

An electronic license plate proposed by Dr. Fred Sterzer, director of the RCA Microwave Technology Center in Princeton, NJ, may make that now little-regarded part of the car an important factor in highway safety, vehicle scheduling and control, theft protection, and traffic control.

The device is described as "a printed-circuit antenna covered by a visual display of the license number, a frequency doubler, a modulator and an rf detector." It would receive signals on an assigned frequency and retransmit them on double that frequency. An integrated circuit encoder would enable the license plate to transmit a signal that would identify the vehice carrying it. Costing only a few dollars to make in quantity, the electronic license plate could:

1. Respond with a vehicle's identifying code when interrogated electronically. (Electronic interrogators (transponders) placed along streets and highways, and connected into a data-processing network could schedule or dispatch ambulances, police cars, trucks or busses more efficiently. Trucking firms could reduce the risk of highjacking by monitoring the progress of trucks carrying valuable cargo. Interrogators could search for cars reported stolen, or report those whose owners were ignoring summonses for traffic violations.)

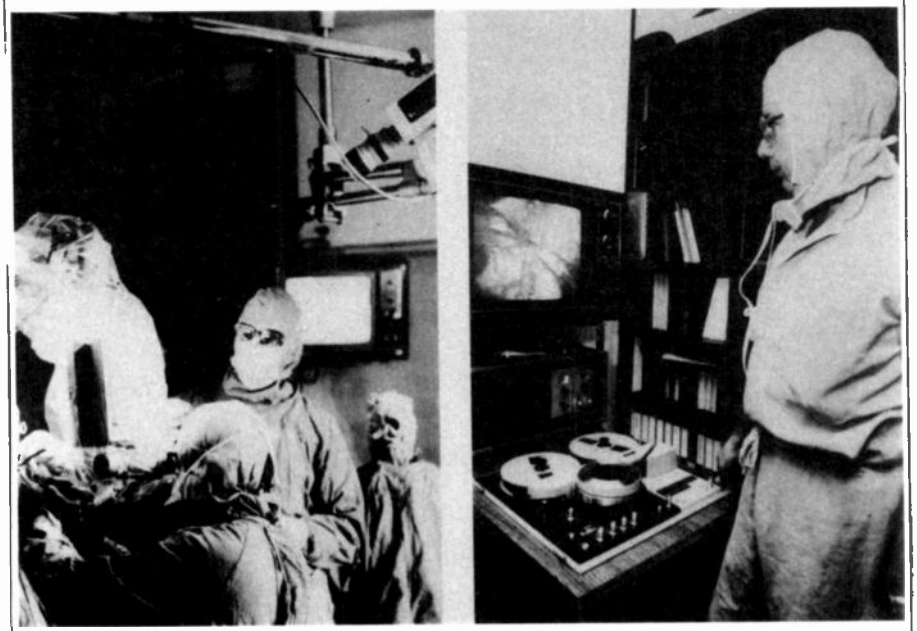
2. Receive and transmit messages to and from a vehicle. (The driver of a disabled car could transmit a coded call for assistance to fixed roadside receivers or to highway patrol cars, and could receive safety messages—or special calls from police vehicles, addressed directly to him.)

3. Serve as a transponder for a collision-avoidance radar. (The electronic license plate meets all the requirements for a second-harmonic reflector, as used in the second-harmonic highway collision avoidance radar demonstrated by RCA in 1972. Such radars avoid the clutter and confusion faced by ordinary radars, since they see only the signal transmitted—at twice the frequency—from the electronic license plate instead of the reflection of the direct transmitted signal, which can be bounced off roadside objects, cars approaching in the opposite lane, etc.)

While the adoption of such a radar system would—like the present adoption of safety seat belts—require legislation or mass manufacturer cooperation, Dr. Sterzer believes that such action would be well-advised. "One person is injured every six seconds and one is killed every ten minutes in the United States," he says. "Increased control over motor vehicles would be a cheap price to pay for reducing this slaughter."

Television inventor Zworykin is unhappy with today's TV

Vladimir K. Zworykin, celebrating his 85th birthday, stated that to him the best control on the TV set is now the "off" switch. In language reminiscent of de Forest's "What have you done to my child?" speech, he said: "When TV (continued on page 14)



COMPACT COLOR TV CAMERA, SHOWN IN PLASTIC AT EXTREME LEFT, televises in color what the operating neurosurgeon sees through his microscope lens.

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Circle 5 on reader service card

new & timely

(continued from page 12)

broadcasting began to develop, I hoped that it would be used for educational purposes, especially so that different cultures could learn to understand each other. Instead, most of the time when I turn on the TV—bang, bang, bang!"

The Russian-born inventor, working for Westinghouse in 1923, demonstrated a crude television camera and receiver. When the head of his department saw it, Zworykin revealed, he said: "Put that guy to work on something more useful!" Later, Zworykin took his neglected device to RCA, where Sarnoff saw its possibilities and supported it to the ultimate commercial success.

CETA of Poughkeepsie area elects its 1974-75 officers

Ron Palluth, CET, of Poughkeepsie, NY, was re-elected president of the Consumer Electronics Technicians Association (CETA), at a meeting held at the Kitchen Restaurant, Hyde Park, NY, last June. Vice president is Ken Parese, CET, of Wappingers Falls, also re-elected. Treasurer is Tom McNamara, Salt Point; recording secretary Dan Ellsworth, CET, Kingston, and corresponding secretary, Dick Jones, also of Kingston.

Lessons from satellite teach teachers to teach

The first instructional television program to be broadcast by a satellite has been originated by the University of Kentucky at Lexington. One program is designed to show teachers how to teach children about adult careers, another includes lessons on conducting remedial instruction. The first programs were carried by land line from Lexington, KY, to Rosman, NC, and transmitted from there to Applied Technology Satellite 6, for re-transmission to waiting teachers from Huntsville, AL, to Fredonia, NY.

A *New York Times* reporter, covering 15 schools in the Applachian area, reports that signals from AT-6 came through strong and clear.

Other educational and medical programs were planned for later in the year, and it is anticipated that next year the satellite may be shifted farther east to transmit educational programs for 5000 villages in India. **R-E**

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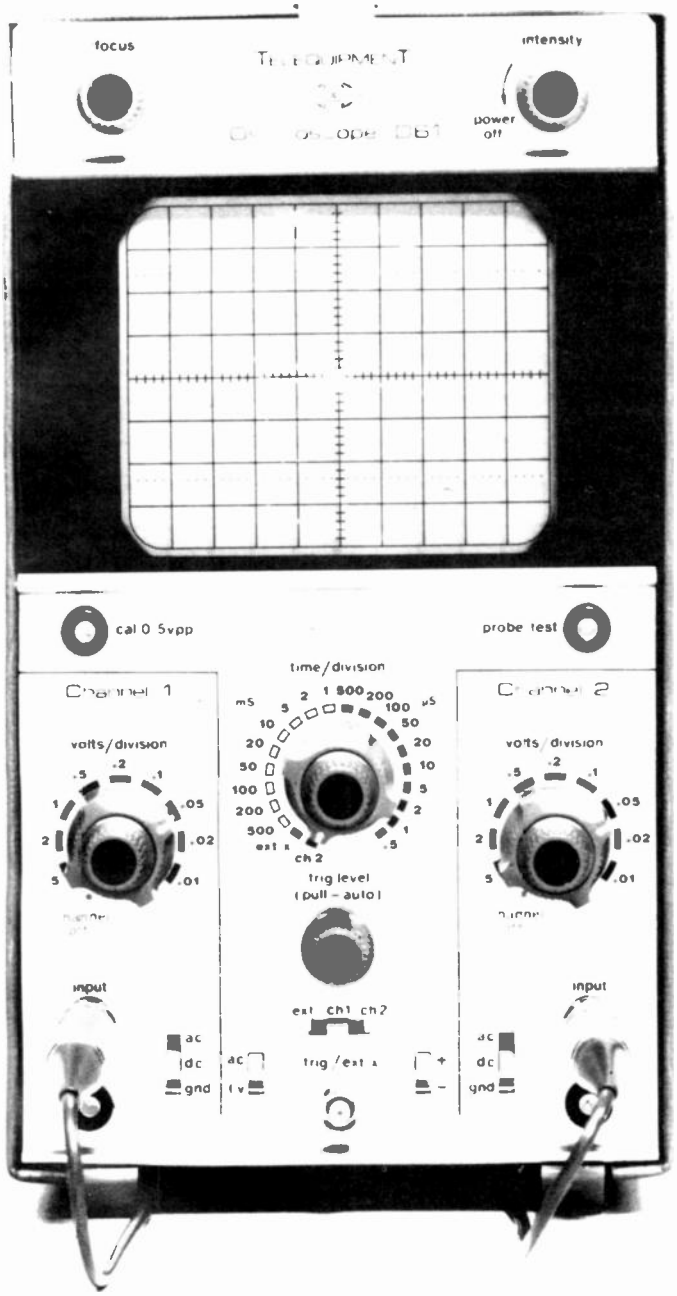

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letters

MORE NEW TECHNOLOGY—PLEASE!

I would like to say that your magazine excells above the other publications when it comes to quality construction projects such as the character generator of the September 1973 issue. I'm sure you have received many letters appreciating this. I did send for the booklet also which I feel was well worth the cost. I have not as yet built the project, but plan to in the near future. I would like to see more projects of this caliber. I would especially be interested myself in monitor-receiver projects.

I like the idea of your magazine presenting new technology to its readers. Computers are now a part of our lives and with the number of calculators now on the market, we service technicians need all the updating we can get. No schooling is available of decent quality to aid technicians to service such equipment, so most people are forced to pay large service fees for manufacturer-oriented service personnel.

The quality of technicians in general is below what it should be overall. The CET licensing program will help tremendously. Shop owners should encourage the study and acquisition of CET certificates to their technicians. Right now, many shop owners either don't seem to know or don't care if a technician even possesses such a certificate.

Thank you again for the opportunity to "sound off."

GERALD F. CLEMENT JR.
Canoga Park, Calif.

City of New York
Dept. of Consumer Affairs
80 Lafayette Street
New York, NY 10013
Elinor Guggenheimer,
Commissioner

Dear Mrs. Guggenheimer:

Re: Chapter 32 title b Art. 44 Admin code.

Thank you for sending us a copy of the New York City Rules and Regulations relating to TV, Radio & Audio Equipment repairs. The following are the observations I have:

1. Estimates have always been and are now a most difficult problem for technicians. Often, diagnosing a problem from the symptoms displayed can lead even the best practicing technicians to believe a certain part is at fault when, in the end, it turns out something completely different is causing it. By requiring an estimate as outlined in the law, the technician and dealer are asked to be very accurate or face a loss or try to amend the estimate later.

I realize this is a most difficult area you have to deal with in the regulations, but it is one where after some experience, your department may want to modify the rules. This may benefit the dealers by relaxing the procedures while benefitting the set owner by allowing the dealer-tech to give more accurate estimates without over-protecting himself.

NESDA (National Electronic Service Dealers Association) is very interested in your experience in this regard and would be most happy to have your opinions on it, later, for our use in helping other areas solve problems in their legislation.

(continued on page 22)

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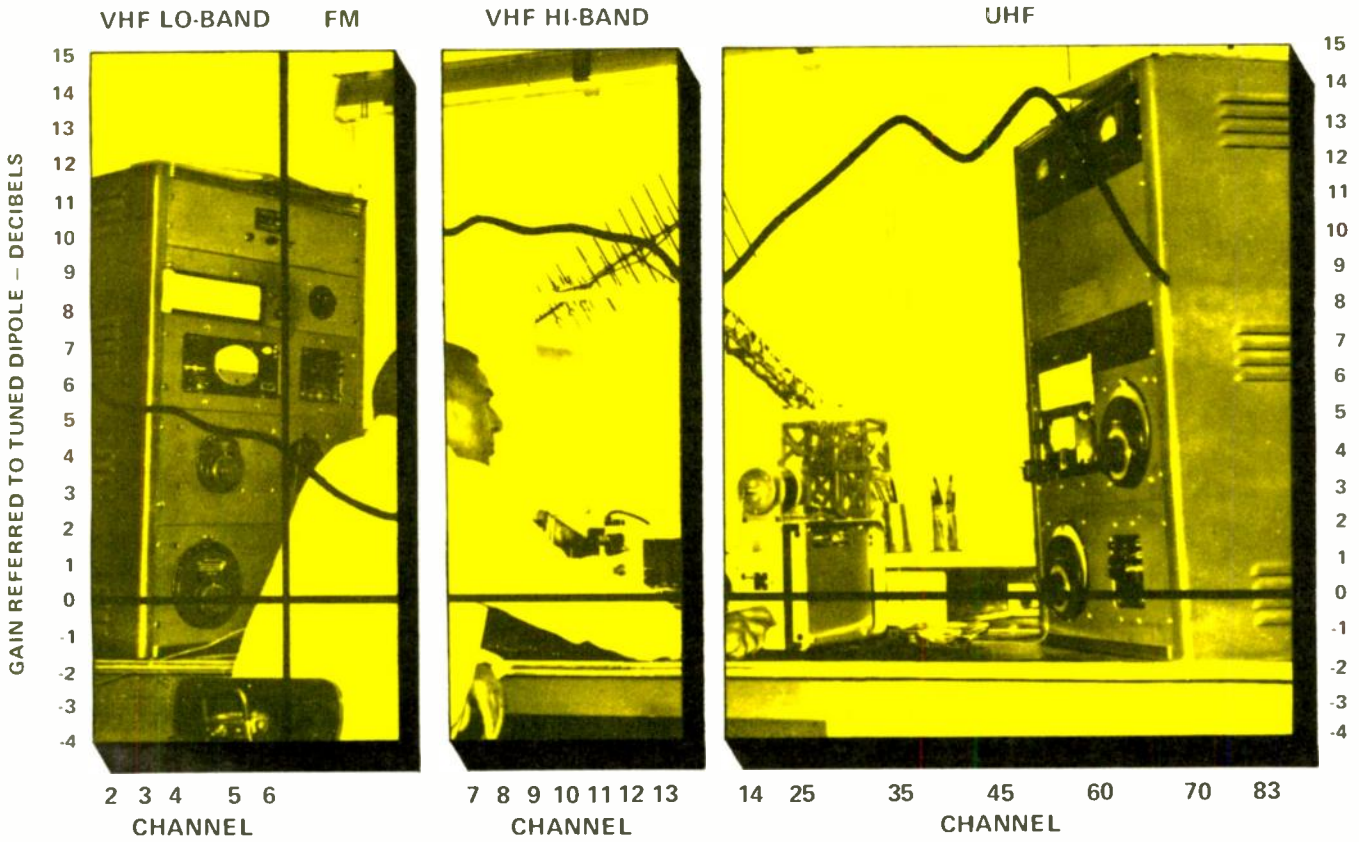

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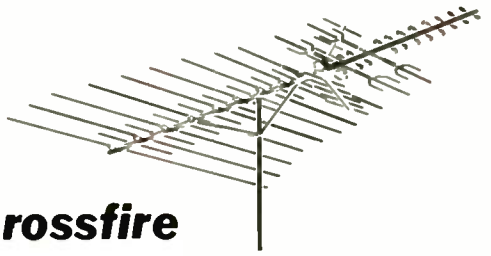

Channel Master Ultra-Hi Crossfire

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Simulated TV Picture/Test Pattern

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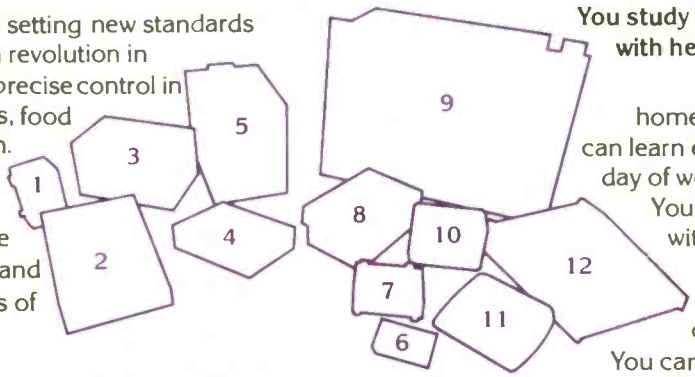

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LETTERS

(continued from page 16)

2. Reg. No. 11 would be interpreted by a majority of judges as meaning any (TV-Set, Stereo, Radio, etc. as a unit) must be warranted or guaranteed, both parts and labor. I don't think that is your intent, but it must be spelled out that only those parts replaced and only the actual repair work charged for are guaranteed. As is, the dealer is expected to be a philanthropist, possibly repairing an inexpensive item (for example) and yet being asked to warrant the $250.00 picture tube!

3. In Indiana and in all other of the nine states with electronic service legislation, there is an industry advisory board. Without these experts to advise you, some common servicing practices may seem wrong when they are right. To discredit a dealer unfairly or your department would lessen the effectiveness of the regulations. Consider appointment of such a board (preferably a five-man board).

4. The $100.00 fee for a dealer license is quite high when compared with that in other states. I realize that for effective administration of the law that you will need investigators, a staff, etc. and other items. However, other governments with fewer shops have been able to have a greatly reduced cost for the license to the shop.

Since this cost, as well as the other costs in time and materials which this regulation will impose on the dealers, must be passed on to the set owners, reduction of the fee would be in the best interest of the public.

5. Equal justice under this act is so vital. Much of the problems of the electronics service business over the years has been caused by people performing service with an unfair advantage. Examples of this are those servicers who operate on a haphazard basis out of their homes, who hide their income thus not paying any taxes on it; who do not protect their customers by having insurance; etc.

If all servicers in New York have to play the game by the same rules equally, this law can be complied with, with the above modifications. However, if enforcement is not certain and swift, the law could merely increase the cost of service and lower its quality.

If I can be of further service to you or the dealers and techs in New York, feel free to call on me.

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Executive Vice President
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AUTOMATIC LIGHT SWITCHES

by JACK DARR
SERVICE EDITOR

AUTOMATIC LIGHT SWITCHES HAVE BEcome quite popular, not only in rural areas but in suburban areas as well. These switches use a very simple electronic circuit; a small relay which is controlled by a photocell. When the outside light is high enough, the relay is energized and the light goes off. Figure 1 is the schematic of a typical unit. This is one of the smaller types, for controlling lamps up to 300 watts. There are several different sizes, including types which can control high-intensity mercury lamps.

The ac current flows through a 5100-ohm resistor (refer to Fig. 1), through a cadmium-sulphide photocell (abbreviated CdS), then through the coil of the relay. The CdS cell here is used as a variable resistor. The arrows are the symbol for a light-actuated device.

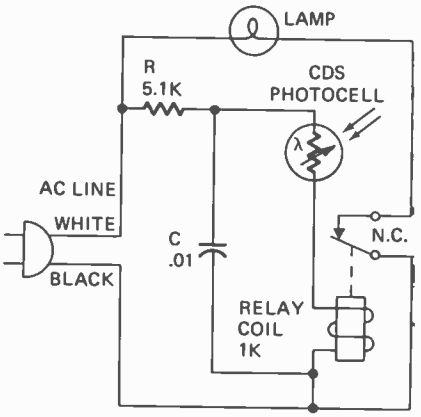

FIG. 1

When the cell is dark, it has a high resistance. More light falling on it decreases the resistance and more current flows. The relay contacts do the actual switching. They are normally closed ("NC") when the relay is *not* energized, and the light goes on. This gives us "fail-safe" operation. If anything goes wrong in the control circuitry, the light remains lit.

The control unit is usually mounted on top of the lamp reflector, under a small metal cover. This will have a little window in it; the photocell is mounted behind this. For best results, this window should be on the north side of the cover when installed. This keeps the direct rays of the sun from falling on it, and gives better control of the light.

To repair one of these, start with the lamp. If the lamp won't light, replace the bulb with a good one. Now, cover the window on the housing with your hand. You should hear the relay click. If this happens, but the light still refuses to go on, turn the power off and remove the cover. There are several hot wires exposed, so don't take any chances.

Check the relay contacts; they may be burned or pitted so badly that they do not make contact, even though the armature of the relay may pull in. In most of these units, the contacts are easily accessible. Pull a strip of fine sandpaper between them, holding the armature down with your finger (power OFF, remember!) Close the relay gently by hand and look at the contacts; you will be able to tell whether they're touching or not. Turn the power on, keeping clear, and recheck the unit to see if it's operating. You can cover the photocell with a piece of dark paper or cloth.

One common cause of damage to these units is a nearby lightning discharge. If this has happened, you will probably see burned parts, charred insulation or carbon "tracks" across insulators. If this is the case, take the unit off and repair it.

Disconnect both wires and remove the control unit and lamp socket. You'll need an ohmmeter to check it. Disconnect the capacitor across the relay coil and check it for shorts. If it has shorted, the 5100-ohm resistor will probably be well charred, too. Replace these, if they're bad. Before connecting them back, check the relay coil. If it too, has been damaged by the lightning, its coil will look very dark, or even charred. Normal resistance of a typical unit is about 1000 ohms.

If the capacitor took a direct hit, its case may have exploded, so that you can't read the markings. Fortunately, they aren't too critical; a .01-μF capacitor at 600 volts is a good size.

While the circuit is opened up, check the photocell. With the surface

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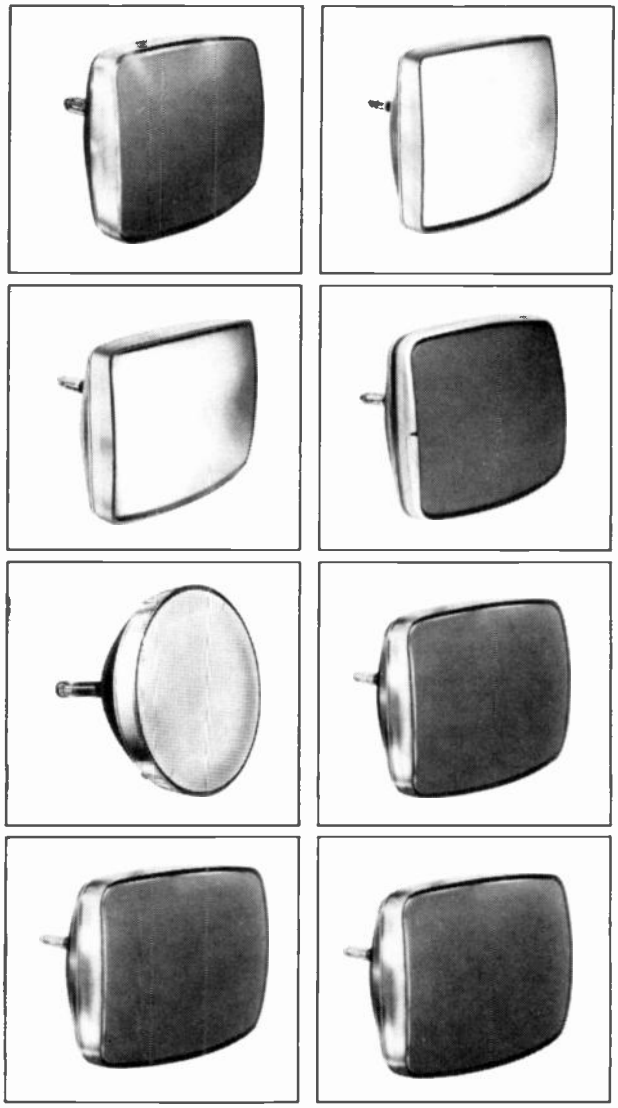
Remember, RCA is the world-wide leader in picture tubes, with over 65 million produced to date.



RCA

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

equipment report

Technics Model RS-676US Dolby Cassette Recorder

Circle 110 on reader service card

WITH EACH NEW DEVELOPMENT IN high fidelity, manufacturers often just dip their toes in the water while checking on what everyone else is doing. Few take the full plunge at once.

But in the Technics (by Panasonic) RS-676US cassette recorder, we find virtually all the latest advancements made in hi-fi in the last few months.

Starting off, the RS-676US is basically a Dolby cassette deck with the addition of special switching and calibration that permits the Dolby processor to be used for monitoring (or recording) Dolby FM broadcasts. Next, we find the tape transport is unlike most other cassette mechanisms you've run across. This mechanism has two motors: one for the capstan drive and one for a "superspeed" rewind and fast forward. Looking even closer we find the mechanism is all solenoid operated—the control buttons operate only solenoids, which in turn provide the mechanical operations. All-solenoid control means remote control is possible, and the rear panel of this recorder has a remote-control socket for an optional control unit, or one you can easily build yourself.

Finally, we come to the *peak/average* VU meters used for setting the recording level. When the cassette system first made the hi-fi scene, it was nothing more than an improved version of the basic Philips casette system, which was intended for recording speech. The reference recording level was pegged at tape saturation for the *average* program level, and signal peaks were driven well into tape saturation distortion — there was no "headroom". To maintain an acceptable signal-to-noise ratio, the reference recording level for hi-fi was maintained at tape saturation; a colossal blunder, because the tape got better but the signal level was still driving program peaks into tape saturation.

With the newer tapes plus Dolby B noise reduction, the signal-to-noise ratio is sufficient to permit reducing the average program level to provide "headroom", and that's just what Panasonic has done in their latest recorder. The 0-VU record level is 6-dB below tape saturation. When the VU meters are switched to NORMAL the meters indicate as do any other level meter, the difference being that 0-VU is 6-dB below 2% total harmonic distortion (from the tape).

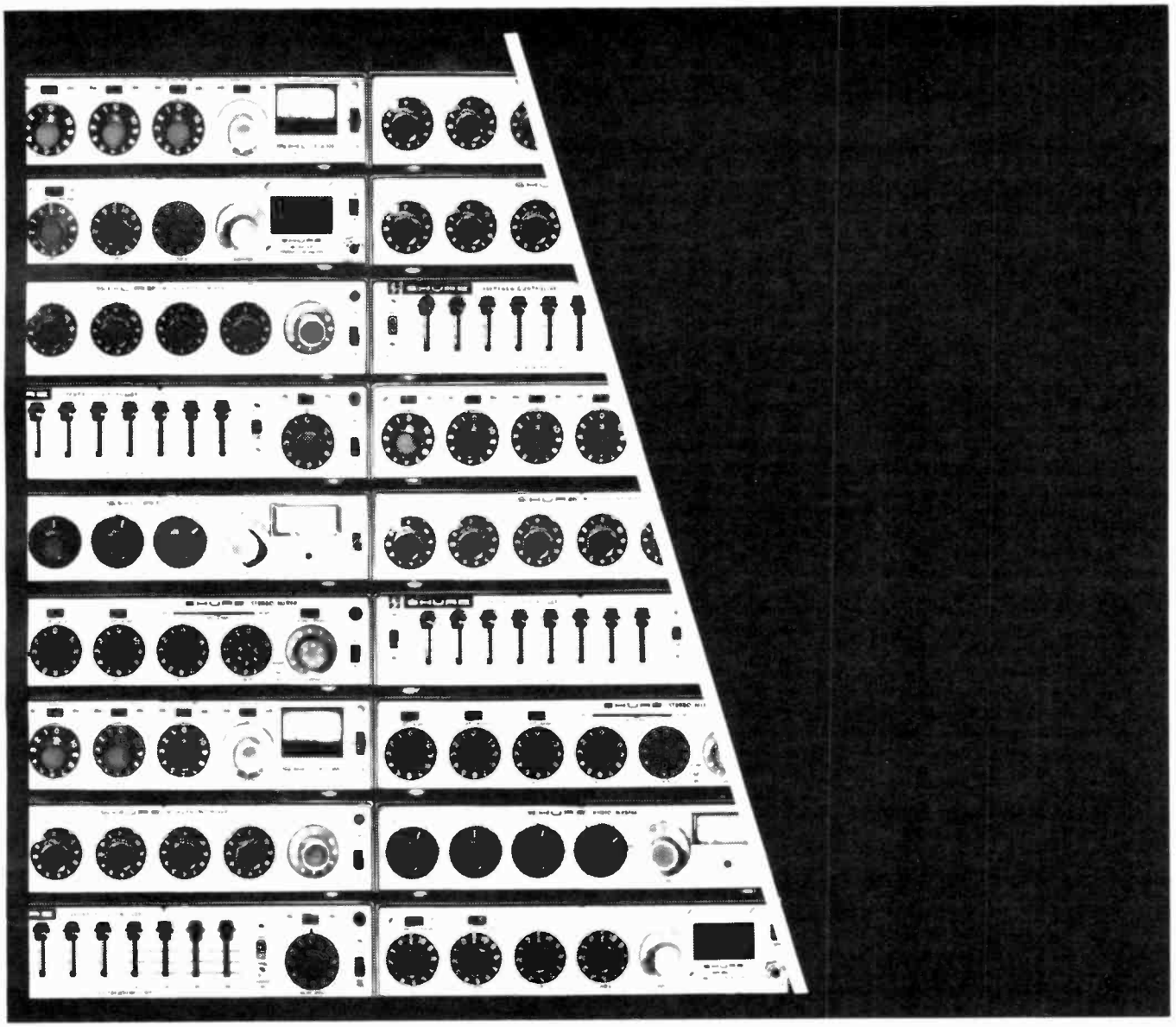
So in one package we find the latest developments in hi-fi: Dolby FM, automatic chromdioxide equalization switching, cassette tape "headroom", solenoid operation and superfast tape wind.

There are controls for record input selection, line/tuner record level, record balance, and concentric left and right microphone record level. There are switches for Dolby B in/out/filter, Dolby FM in/out, tape type and peak/normal VU meters. Left and right screwdriver-adjust controls on the front panel permit calibration of the Dolby FM circuit to 50% modulation —the Dolby reference level for FM broadcasts. (FM stations transmit the calibration tone once or twice a day; and once the controls are adjusted their setting is permanent as long as the same FM tuner is used.)

The FCC has recently allowed Dolby FM stations to use a 25-μS pre-emphasis instead of the standard 75 μS. The recorder has a 75/25 μS COMPENSATION switch on the rear to permit optimizing recording and reception of either pre-emphasis. When the recorder is set to Dolby FM, the output to the amplifier's tape monitor is "flat"—the Doly processor can be used for straight listening as well as recording.

The tape mechanism has pushbut-

(continued on page 110)



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while the guy down the street complains about how tough alignments are...I do them!

Model 415
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I used to hook up a separate sweep generator, marker generator, marker adder and bias supply, hope that everything was properly calibrated and adjusted, and pray that the alignment would hold after I disconnected the cables draped all over the bench.

I didn't do it very often.

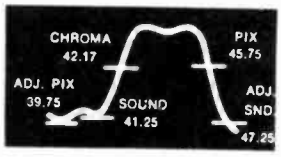
Now, in the time it used to take me just to set up, I can almost complete an alignment. And I'm confident the set will perform as well as it possibly can. My customers notice, too. That's the difference B&K's 415 Solid-State Sweep/Marker Generator made.

Setup is no problem. After I connect the 415's outputs to my scope (there's even low-frequency compensation to eliminate pattern errors), I connect its RF outputs (channel 4 or 10) to the antenna terminals or mixer test point, the direct probe to the video detector test point (or anywhere else after the video detector diode) and the demodulator probe to the bandpass amplifier output.

They're all clip-on connections, and the 415 comes with all the accessories I need. Once I've made the initial signal and bias hookups, there's nothing else to connect or reconnect. All intercabling changes and generator functions are controlled from the front panel. There's even a 15,750Hz filter to eliminate disabling the set's horizontal output section.

Shaping the waveform is easy, because the 415 has 10 crystal-controlled IF markers, each of which lights up on the front-panel waveform diagram as it is used. Markers can be shown either vertically or horizontally on the scope trace. There's a 100kHz modulated marker that makes nulling the traps so easy it's almost automatic. And three low-impedance, reversible-polarity bias supplies—two, 0-25VDC; one, 0-50VDC.

Vertical Markers



Markers Tilted Horizontally

Every step is easy to understand, too, thanks to the comprehensive manual.

Since I have nothing to sell but my time, I have to make the most profitable use of it I can. That's why I have a B&K 415.

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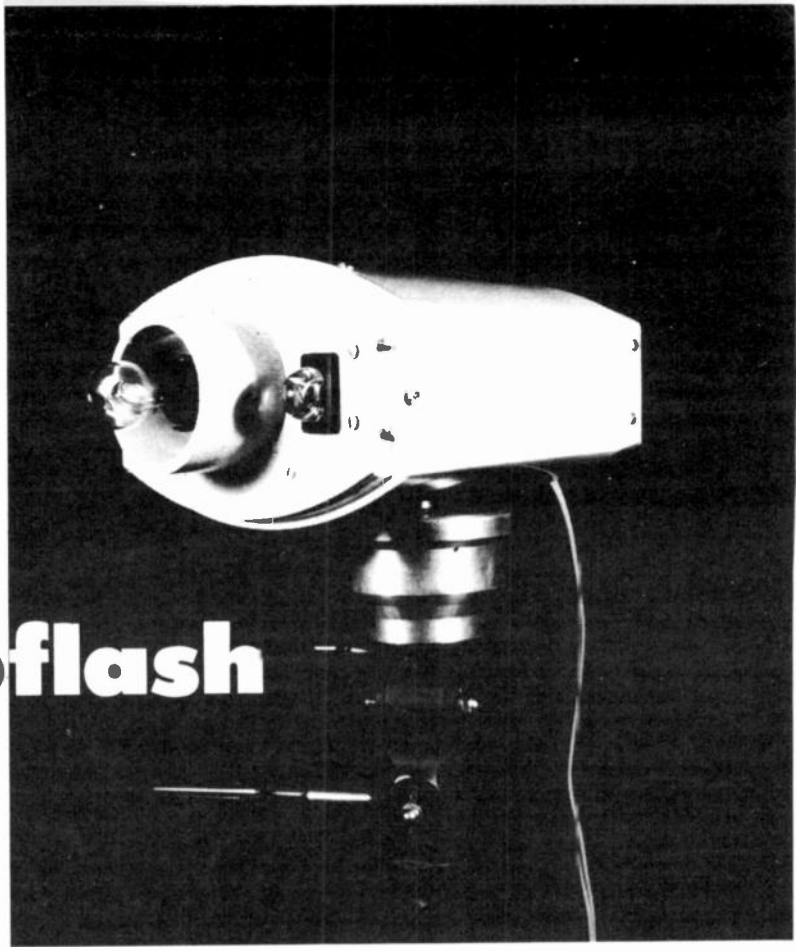
BUILD 200 Watt-Second Photoflash



Build any of the three bare-bulb photoflash units described in this article. An optional optical trigger is also described.

by JIM GUPTON

BARE-BULB ELECTRONIC PHOTOFLASH units are becoming increasingly popular with amateur and professional photographers. Soft shadows and wide angle coverage increase the versatility of any camera and make those "Impossible" group shots... possible. Add a Lawson Enterprises "Reflectasol" to a bare-bulb photoflash and you have a professional studio light source for color portraits. By obtaining power from the standard 117-volt ac line, you eliminate the weight and expense of batteries and have the fastest recycling time of any electronic photoflash on the market.

This article contains the construction details for three bare-bulb photoflash units. The first unit uses computer-grade capacitors and has an output of 200 watt-seconds. The second unit has an output of 100 watt-seconds and uses standard photoflash capacitors. A selectable output unit having 50, 100, 150, and 200 watt-second outputs is also described.

All three photoflash units can also be used as slave units with an optical trigger circuit that is described. As a slave unit, the photoflash is triggered with the light from a photoflash mounted on your camera. This eliminates the need for sync cords and permits the placement of the slave unit anywhere in the picture taking area. Optically triggered slave units are commonly used among professional photographers.

Of all electronic construction projects, none can be more deadly than the electronic photoflash unit. Voltages ranging between 400 and 500 Vdc, at a current of 1 ampere, can kill you! Therefore, every step of the construction, including the final assembly and testing, must be and is, engineered to protect you against accidental shock hazards and possible fatal injury. It is imperative that no deviation from the specified material be attempted. When constructing one of the three alternate photoflash circuits, observe capacitor polarity at all times.

Plastic canister housing

The electronic circuits for the bare-bulb electronic photoflash must be housed in a shock-proof container. Metal cases offer considerable physical protection, yet the metal exterior is likely to become charged and it will create a shock hazard when contact is made with a common ground circuit. The ideal case to house the bare-bulb photoflash can be found in the household section of most any department store or discount house. The article's housing was originally one of a set of four kitchen canisters. It has rigid side walls and ample inside dimensions to house the electronic circuits securely with complete protection from accidental shock hazards.

To eliminate the molded handle grips and bottom depressions of the canister's top and bottom, simply cut away the surface containing the raised handle and bottom depressions, and replace it with a matching contour section of fiber glass printed-circuit board. The fiber glass board provides a metal shielding surface and is rigid and thin enough to support the flash tube circuits. They are easily attached to the plastic top and bottom with epoxy cement and small aluminum angle sections to assure firm attachment and rigidity. In my model, a metal ring surrounds the flash tube to provide mechanical protection to the tube and to serve as support for a large reflector. Remember that the wall thickness is an important item in selecting your plastic canister. The plastic walls must have enough strength to support the photoflash when mounted on a tripod. Flexible plastics should not be substituted as they cannot meet the support requirements.

Power-capacitor bank circuits

The schematic circuit diagram in Fig. 1 illustrates two types of capacitor banks. One type of capacitor bank is series connected, provides a 200

watt-second output, and is shown in Fig. 1-a. Figure 1-b shows the alternate, parallel circuit which provides a 100 watt-second output.

The series circuit takes advantage of high-capacitance computer-grade capacitors for high output power at a minimum of space requirements. However, there are some who may be apprehensive about the ability of computer-grade capacitors to hold up under rapid discharge cycling and of the higher leakage rate common with this type of capacitor. The alternate, parallel circuit employs the standard photoflash capacitors for maximum power output and requires a larger canister housing.

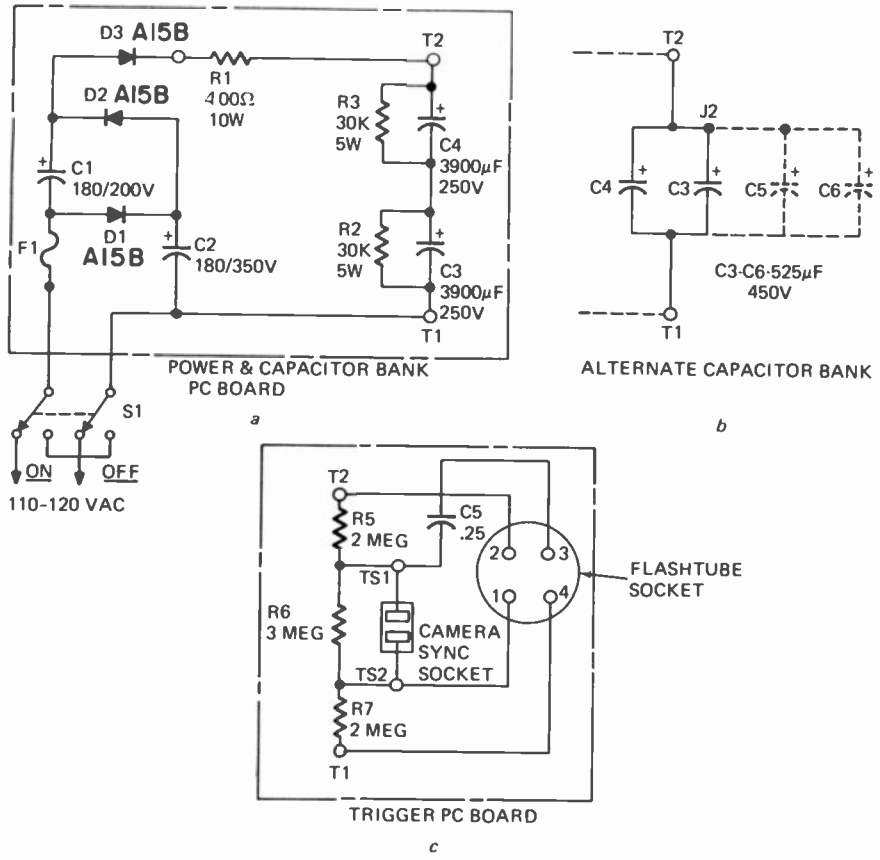


Fig. 1—BARE-BULB PHOTOFLASH CIRCUIT. Circuit a shows the series capacitor bank which provides a 200 watt-second output. Circuit b shows the alternate capacitor bank which provides a 100 watt-second output. With the optional addition of capacitors C5 and C6, circuit b provides 200 watt-seconds. An optional switch wired between the positive terminals of the capacitors in circuit b will also provide multiple power output ratings. Circuit c is the trigger circuit.

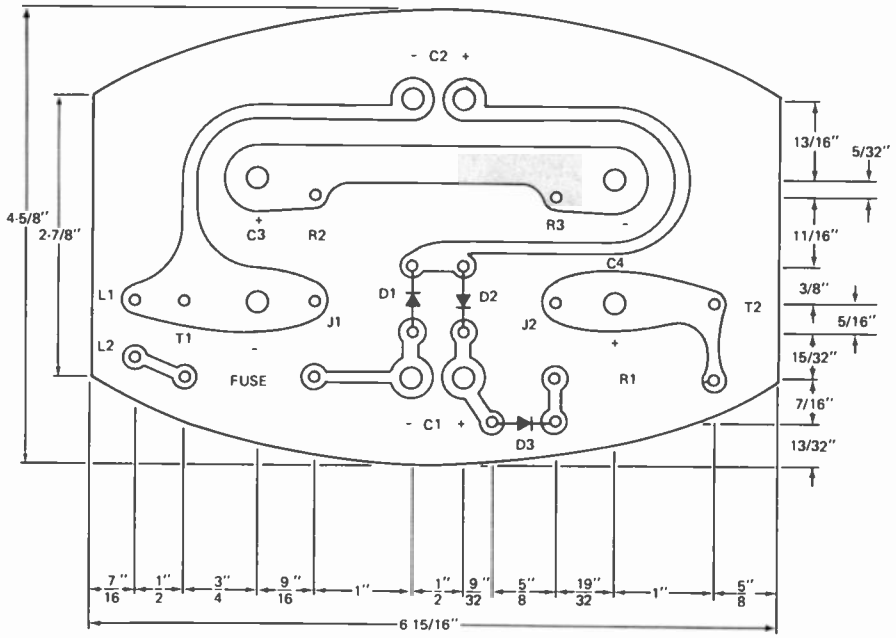


FIG. 2—FOIL PATTERN for series capacitor bank which provides 200 watt-second output. This foil pattern is also used for the parallel capacitor bank, having an output of 100 watt-seconds, with a jumper connected between J1 and J2 and other modifications (see text).

Computer grade capacitor circuit

The circuit board illustrated in Fig. 2 can be used for computer-grade capacitors in series or standard photoflash capacitors in parallel with minor changes. The series circuit employs Mallory 3900-μF. computer-grade capacitors. This amount of capacitance will produce a 200 watt-second output to the flash tube. Resistors R2 and R3 serve to equalize the voltage across the capacitor discharge bank, C3 and C4. To produce the charging dc voltage

SLAVE TRIGGER PARTS LIST

SC1—National Semiconductors Ltd. NSL-701-3, 3-element, series-connected silicon cell
C1—0.01 μF ceramic disc capacitor 50 Vdc
R1—39K; ¼-watt resistor
SCR—General Electric C106B3 SCR Ac plug

TRIGGER CIRCUIT PARTS LIST

R5, R7—2-megohm 1-watt resistor
R6—3-megohm 1-watt resistor
C5—.25μF Mylar capacitor 400 Vdc
Flash tube socket, standard 4 pin radio socket
Flash camera sync socket, standard ac socket
Flashtube DX-5—Kemlite Laboratories, 1819 W. Grand Ave., Chicago, Ill. 60622

200 WATT-SECOND SERIES CAPACITOR POWER PARTS LIST

S1—Dpdt switch-rocker or toggle type, Allied Electronics No. 700-5110 or equal
F1—1¼ amp. Slow-Blow
D1, D2, D3—General Electric A15B or equal 1A 200V silicon rectifier
R1—400-ohm, 10-watt resistor
R2, R3—30K, 5-watt resistor
C1—180 μF/200 Vdc Mallory No. CG181T200A1
C2—180 μF/350 Vdc Mallory No. CG181T350B1
C3, C4—3900 μF/250 Vdc Mallory No. CGS393T250FH1
Ac line cord and plastic strain relief.

PARALLEL CAPACITOR—POWER PARTS LIST

S1—Dpdt switch, rocker or toggle type, Allied Electronics No. 700-5110
F1—1¼ amp. Slow-Blow
D1, D2, D3—Silicon rectifier GE type A15B or equal
R1—400 ohm, 10 watt resistor
C1—180 μF/200 Vdc Mallory No. GC181T200A1
C2—180 μF/350 Vdc Mallory No. GC181T350B1
C3, C4, C5, C6—525 μF/450 Vdc Mallory type FF45052 or equal

for C3 and C4, capacitors C1 and C2, in conjunction with the silicon diodes D1, D2, and D3, form a voltage-tripler circuit to transform 117 volts ac into 450 volts dc. Fuse F1 is rated at 1 ampere and must be of the Slow-Blow type due to the greater current drain during the initial forming of computer-grade capacitors. Likewise, the current limiting resistor R1 is rated at 10 watts and must be mounted no less than ⅛ inch above the circuit board to properly radiate the heat generated in the initial forming operation.

A jumper is indicated at J1 and J2 of Fig. 2. The jumper is only used when modifying the circuit board for standard photoflash capacitors and is not required for series capacitors. The dimensions indicated on Fig. 2 are to locate drill centers for components and capacitors. All electrolytic capacitor terminal holes are ¼ inch in diameter. When mounting the capacitors, be sure that the number 10 washer is between the copper circuit and the capacitor terminal with the mounting screw inserted through the ¼-inch hole from the component side of the circuit board. Be sure the correct polarity is observed in mounting the capacitors.

Parallel standard photoflash capacitors

Only minor modifications are needed to convert the circuit board in Fig. 2 to the parallel-connected standard photoflash capacitor bank. The 1050 μF capacitance (525μF + 525μF) will produce an output of 100 watt-seconds or, if you prefer, you can use the larger circuit board in Fig. 3 with four standard photoflash capacitors. This will produce a 200 watt-second output similar to the computer-grade series capacitor circuit. In parallel use, the circuit board in Fig. 2 does not require R2 and R3. The 10-watt resistor R1 must now be connected between the cathode of D3 and the heavy foil strip running across the top of the board. (Use the holes provided for R3 in the series-capacitor circuit.) Capacitor C4 *must be reversed* in polarity so that the positive terminals of C3 and C4 are attached to the plus bus circuit. Now connect a number 18 wire between jumper terminals J1 and J2. Trigger terminal T2 cannot be used as shown. Move it to the positive terminal bus at point R2. No change is made to the voltage-tripler circuit or its associated capacitors or diodes.

The four-capacitor parallel circuit (Fig. 1-b, using the circuit board in Fig. 3) can be modified to provide selectable light output. For a choice of either 100- or 200-watt-second output, connect a single-pole, heavy-duty

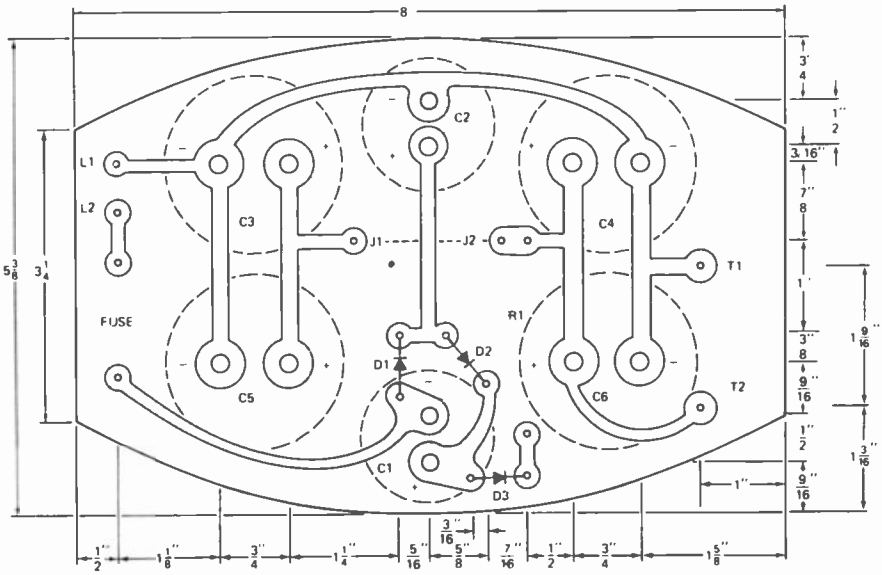


FIG. 3—FOIL PATTERN for parallel capacitor bank which provides 200 watt-second output (connect jumper between J1 and J2). With modifications, the foil pattern is also used for the multiple power output flash (see text).

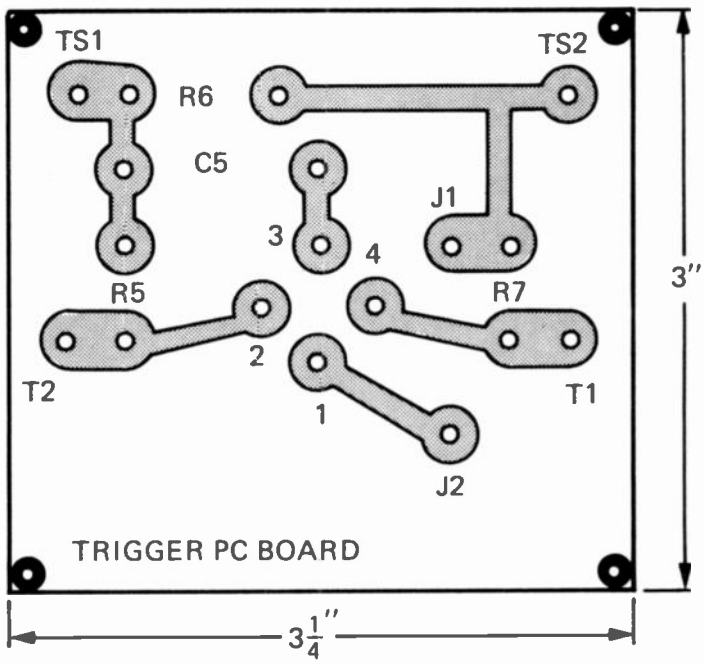


FIG. 4—FOIL PATTERN for the trigger circuit.

toggle or rocker switch instead of the jumper between points J1 and J2 in Fig. 3. For a choice of 50, 100, 150 or 200 watt-seconds, modify the circuit board by removing the copper foil paths between the positive terminals of C3 and C5 and C4 and C6. Install a heavy-duty single-pole, 4-position *progressive-shorting* switch on the housing top. Connect the four terminals to the positive terminals on C3—C6 and the arm to point T2.

WARNING: ONLY POWER-CAPACITOR BANK (Fig. 1-b) CAN BE MODIFIED WITH OPTIONAL POWER SELECTION SWITCH. UNDER NO CIRCUMSTANCES SHOULD A POWER SELECTION SWITCH BE ATTEMPTED ON FIG. 1-a SERIES-CONNECTED COMPUTER-GRADE CAPACITOR CIRCUIT. PLACING ONLY ONE CAPACITOR ACROSS 450 VOLTS DC WILL PRODUCE A DANGEROUS OVERLOAD OUTPUT AND CREATE A POTENTIAL EXPLOSIVE CONDITION IN THE CAPACITOR.

Trigger circuit board

The trigger circuit shown in Fig. 1-c is simple with only 4 components. The PC board for the trigger circuit is shown in Fig. 4. Since the flashtube socket is on the component side of the circuit board, some minor difficulty may be encountered in connecting the flash tube socket to the circuit connections 1, 2, 3, and 4. All that is necessary to make the proper connections is to attach number 16 solid wires to the 4 tube socket pins and insert the other end of the wires in the corresponding

print board contact holes and solder. Firm mechanical connections must be made to the tube socket pins to prevent solder heat from breaking a solder-only connection.

To mount the trigger board to the housing's top, attach 4 stand-off terminals to top and solder stand-off pins through 4 corner holes of the trigger circuit board. TS1 and TS2 connect to the camera sync socket which consists of a standard ac connector, with either number 16 or 18 flexible, stranded wire. The camera sync socket is mounted on the housing's top and can be either a push-in, snap-lock, or screw-mounted socket. This location for the sync socket minimizes the number of connections between trigger circuit board and the power-capacitor bank and places the sync socket in the most advantageous position for use with an optical slave trigger.

Power input connections

Ordinarily, one would expect the power switch discussions to be along with the 117-volt ac tripler circuit. However, because there is a potential shock hazard associated with the ac power switch, it is described separately. Only a double-pole double-throw switch should be used in the ac power line. The ac line must be connected to either the two top or two bottom terminals of the switch with the power-capacitor bank connected to the center terminals of the switch and a jumper connected to the unused terminals. This connection, shown in Figs. 1-a and 5, prevents voltage feedback through the switch to the ac plug terminals and eliminates a potential shock hazard. It also provides a capacitor discharge shunt when the switch is in the OFF position, to remove dangerous stored capacitor voltages.

Optical slave trigger

The most valuable accessory to electronic photoflash photography is the optical slave trigger for your photoflash (Fig. 6). It triggers the photoflash with the light from your camera mounted photoflash and eliminates the use of two sync cables. Figure 7 illustrates how the four components are assembled on the prongs of an ordinary ac plug and encapsulated in a clear plastic or epoxy resin. The General Electric C106B3 SCR is specified not only for the electrical specifications but for the anode terminal position opposite the gate and cathode terminals. This is most convenient for mounting the SCR on the prongs of the sync plug.

The light-sensitive device is a National Semiconductors Ltd. type NSL-701-3 silicon photodiode. It consists of three 0.1 x 0.2 in. silicon chips connected in series to provide sufficient voltage output to trigger the SCR when struck by the light from the master flashgun. The NSL-701-3 can be purchased for $6.00 from National Semiconductors Ltd., 331 Cornelia Street, Plattsburgh, NY 12901.

(The NSL-701-3 is sold as an assembly of bare silicon chips. These are very fragile and easily damaged. If you wish, you can purchase a complete optical trigger—ready to plug into the flashgun from most photo equipment supply houses for approximately $15.00. The device is the Wein Micro Slave.—*Editor*)

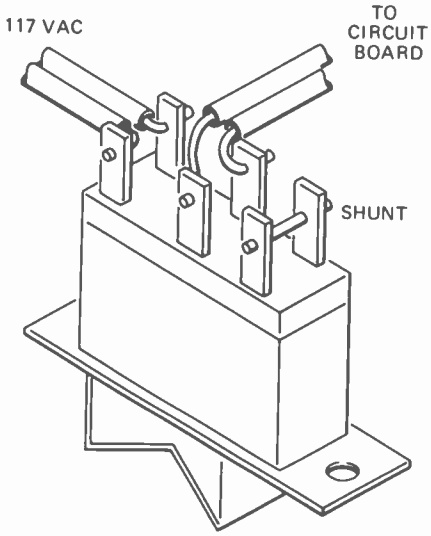


FIG. 5—AC POWER SWITCH wiring.

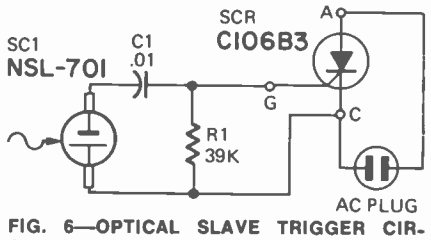


FIG. 6—OPTICAL SLAVE TRIGGER CIRCUIT.

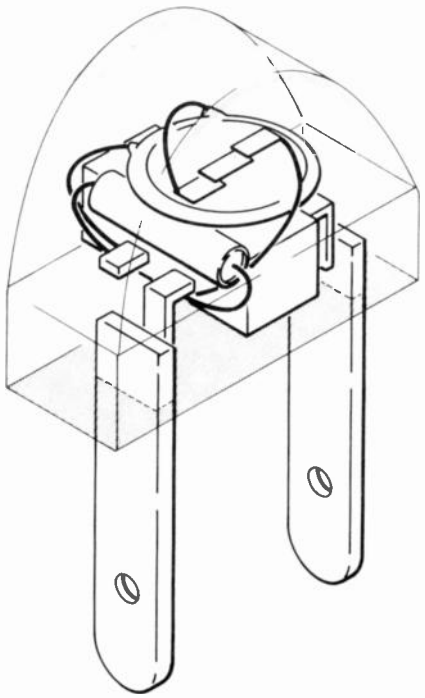
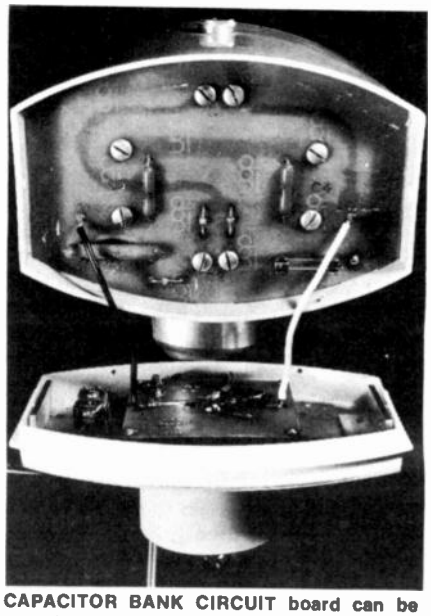


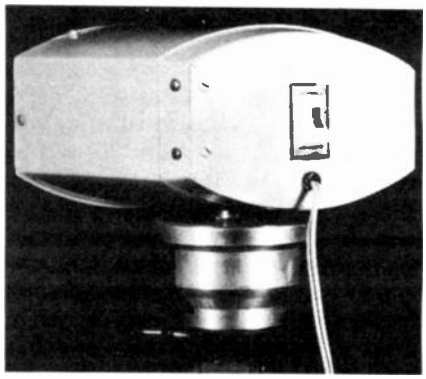
FIG. 7—OPTICAL SLAVE TRIGGER component placement diagram.



CAPACITOR BANK CIRCUIT board can be seen from component side of board.

Final assembly

Upon completion of the power-capacitor bank and trigger circuit boards, the final mounting of components in the plastic housing is begun. Figure 8 shows the side view of the component mounting inside the canistor housing. The ac power switch is mounted on the bottom plate of the housing with the 117 volt ac line connected to the end terminals on the switch and a shorting jumper connected across the opposite end terminals (see Fig. 5). Connect a 10-inch section of ac cord from the two center terminals of the switch and run it towards the top of the housing. Next, insert the power-capacitor bank circuit board to locate the tripod mounting position. The correct position for the tripod mount is slightly below the bottom of capacitor C1, with enough space below C1 for adequate backplate support. The tripod socket can



REAR VIEW OF PHOTOFLASH unit mounted on tripod shows power cord and ac switch.

If you select the variable-output circuit for your flashgun, you'll find a progressive-shorting switch almost impossible to obtain because it appears that they're now being made only on special order.

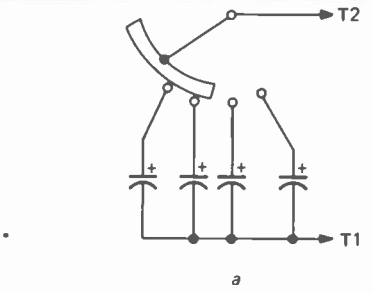
Do not be misled by the terms "shorting" and "non-shorting" in switch catalogs. A shorting-type switch has its arm or wiper arranged so it establishes a new contact before breaking the old. In a non-shorting switch, the wiper breaks contact with one terminal before it makes contact with the adjacent one.

A progressive-shorting switch has a long wiper that progressively connects or shorts the fixed terminals until all are tied together. Your best chance at a suitable switch of this type is to salvage one from a surplus radio transmitter or antenna tuning unit. Diagram *a* shows how to connect it. (I have a hunch that the burners on electric ranges have a similar switch so you might look into this.)

If you can't find a progressive-shorting switch, you can make an equivalent from by wiring a 4-pole, 4-position rotary switch as in diagram *b*. It should have ceramic wafers and contacts rated at at least 5 amps at 350 volts dc.

The DX-5 flash tube is rated at 150 watt-seconds maximum, However, the author assures us that he has not noticed any shortening of the tube life due to its operation at 200 watt-seconds. Furthermore, this tube is used in several commercial 200 watt-second flash guns.

—Editor



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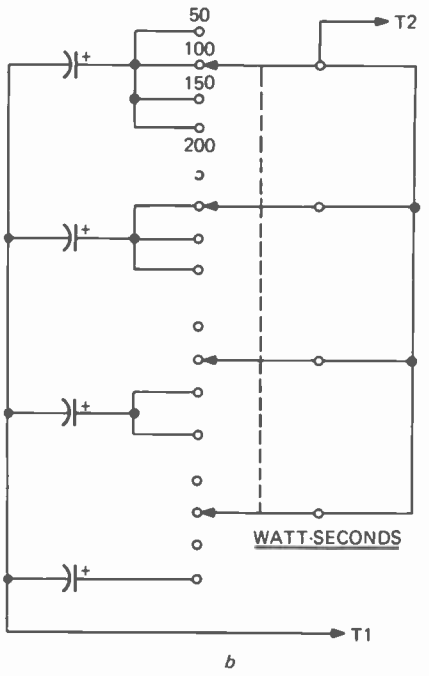

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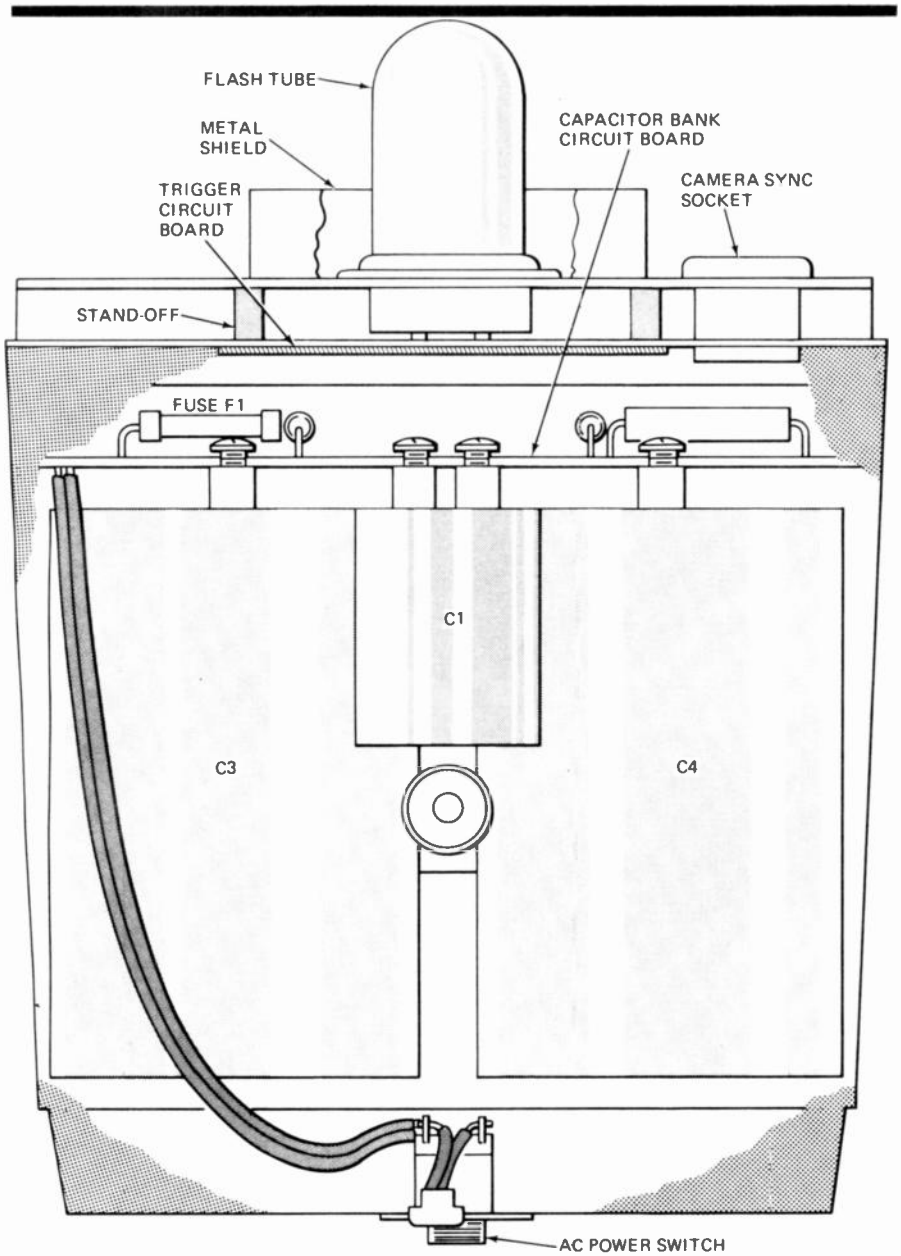

FIG. 8—COMPONENT PLACEMENT DIAGRAM for the barebulb photoflash unit.

be made from a 1-inch circle or square plate of aluminum or brass, ¼ inch thick and with a ¼-20 threaded hole in the center point of the plate. Or, if you prefer, a tripod socket may be purchased from your local camera store or a quick-release tripod base is available from Edmund Scientific Co., 101 East Gloucester Pike, Barrington, N.J. under catalog number 40941. With the tripod socket installed, wrap the capacitor bank, below the print board, with plastic film or acetate sheet and tape securely. This wrapping offers additional electrical shielding and will contain capacitor electrolyte should a capacitor rupture for any reason.

Insert the power-capacitor circuit into housing and firmly seat the pc board to housing sides. A small piece of tape is sufficient to secure the entire assembly if the pc board has been accurately contoured to the housing's interior dimensions. Attach the trigger circuit connections and insert the top of the housing onto the housing body. However, do not secure the top to the body at this point. Insert the flash tube in the flash tube socket.

(continued on page 80)

Why a Sylvania home training program may be

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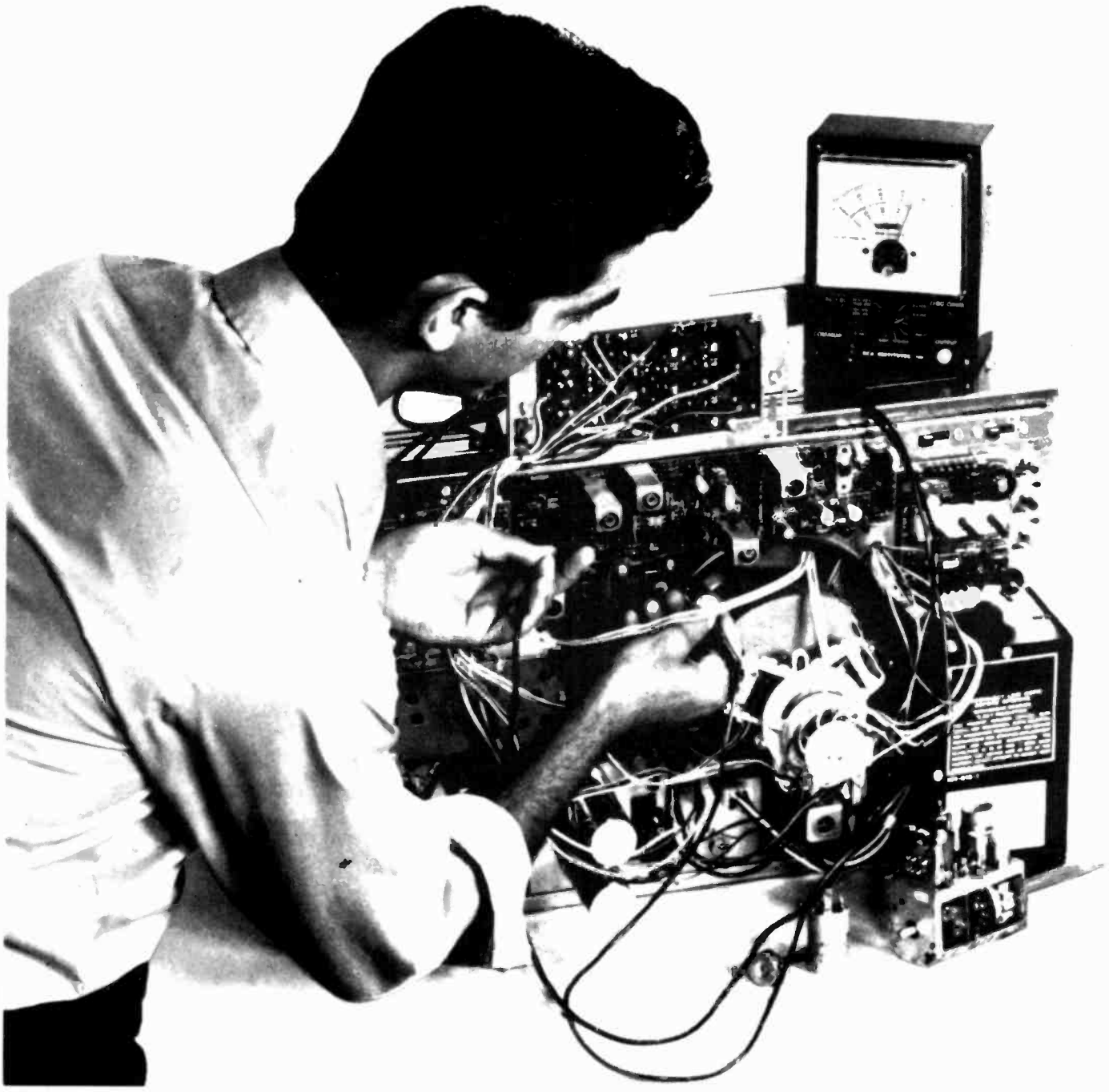

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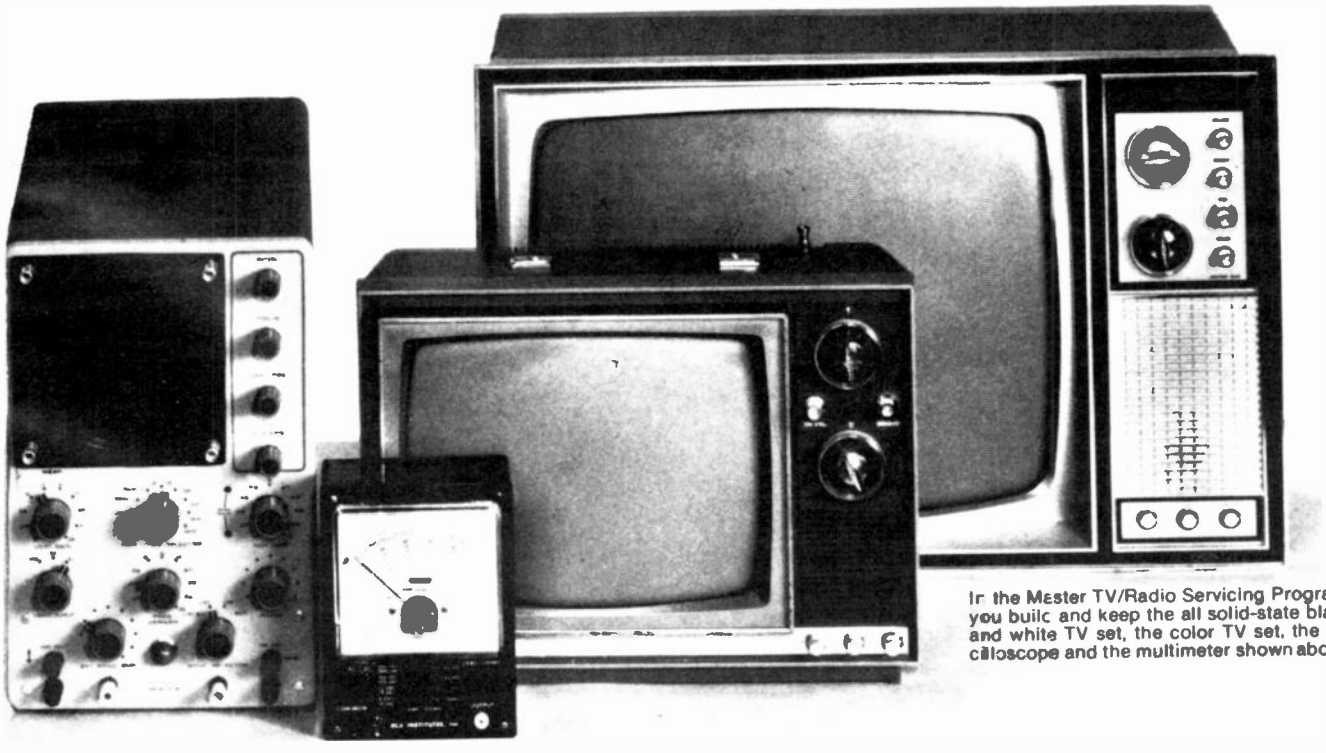


In the Master TV/Radio Servicing Program, you build and keep the all solid-state black and white TV set, the color TV set, the oscilloscope and the multimeter shown above.

EXCLUSIVE!
First Computer You Build

This is a special report terminal in kit form. It a computer directly or via

THE LOW COST MINI-COMPUTER IS A reality today. Together with time-sharing systems, they are performing an increasing number of tasks in all types of applications.

However, the relatively high cost of terminals has slowed both the acceptance and the use of the computer in small businesses, homes, and schools. The MITS Comter 256 (CT256) computer terminal described here can be built for less than ½ the cost of most terminals and offers many unusual features not found in terminals costing several times as much.

The terminals important features include:

A built in acoustic coupler making computer connection simpler and saving added cost.

An auto-transmit that allows transmitting data or program material to the computer from memory, line by line.

Complete cursor control by software as well as by manual control via the keyboard.

A tape recorder input/output jack to enable taping of frequency shift keyed (FSK) tones during telephone connection to a computer. This gives virtually unlimited memory capability. Almost any type of tape recorder may be used.

A 32-character Burroughs display with a soft orange, highly legible readout.

Standard ASCII encoded keyboard with TTY-33 format.

Internal memory capability of 256 characters per page and up to 4 pages of memory.

Automatic page change at the end of each page for a total of 1024 character storage for a 4-page unit.

Flexible power requirements. Operable from line voltage of 100 to 130 volts or 200 to 260 volts.

A 25 pin input/output accessory jack for hardwire computer connection and add-on accessories.

Data flow in the terminal

The block diagram of the Comter 256 (Fig. 1) represents considerable digital circuitry (91 logic IC's in a 4-page unit). The data path starts at the keyboard. When a character key is depressed, the character is encoded into a 7-bit binary code and is sent in parallel form on 7 lines to the UART (Universal Asyncronous Receiver-Transmitter—a 40-pin MOS chip) which converts the character data to serial information. The serial data is sent to the FSK modulator which converts a binary 1 to 1270 Hz and a binary 0 to 1070 Hz.

These tones are transmitted from the acoustic coupler to the computer, via the telephone lines. The computer processes the data and returns it back over the telephone wires to the terminal at a different frequency (binary 1 = 2225 Hz, binary 0 = 2025 Hz). The data is fed to the acoustic coupler where the tones are amplified, filtered and demodulated back into serial binary coding.

From the demodulator, the serial data goes to the UART and is converted to parallel form where it waits to be loaded into memory. When a data available signal from the UART coincides with the 32nd character display time for the self-scan (right hand end of display), the first 6 bits of the character are entered into memory (the seventh bit is not used in the CT 256 memory) and the data position is automatically moved one position to the left.

The self-scan display is connected to the memory so that as a character is entered into memory it is simultaneously displayed along with the other characters in memory. This process is repeated for every character

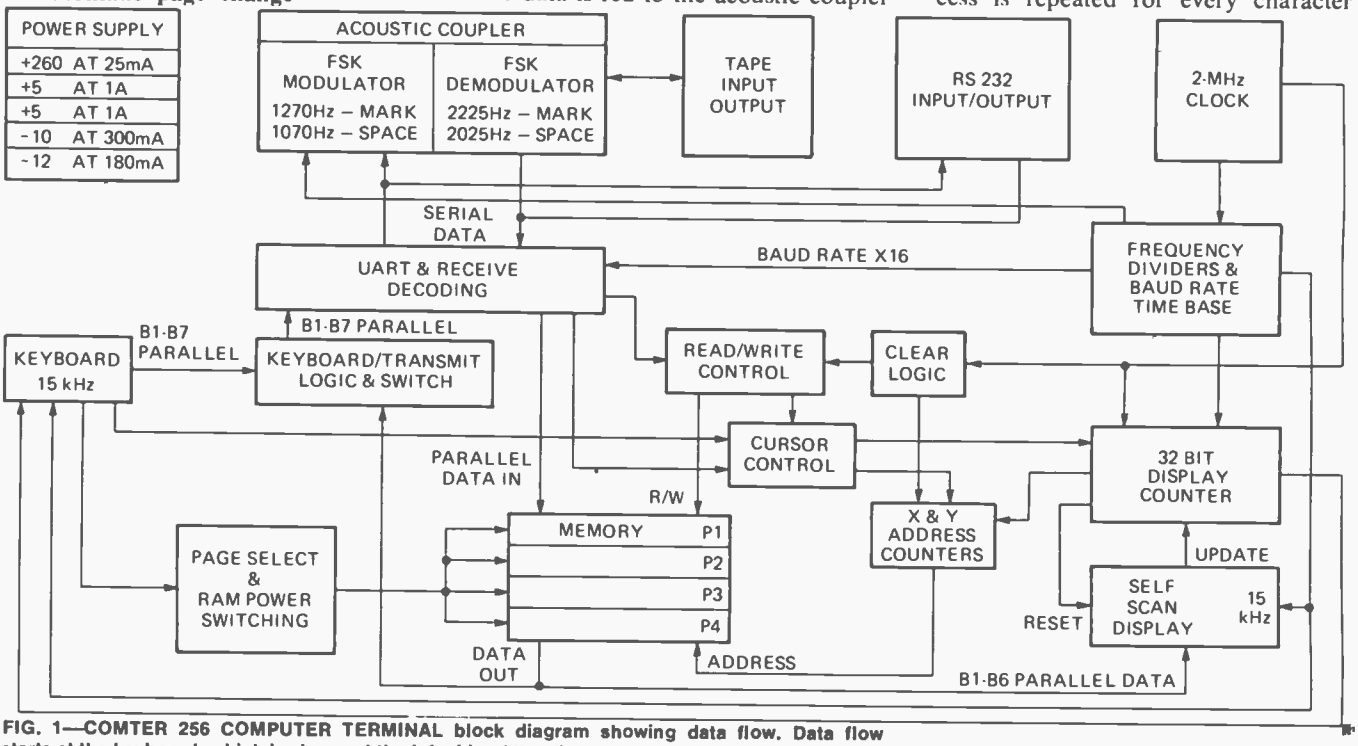


FIG. 1—COMTER 256 COMPUTER TERMINAL block diagram showing data flow. Data flow starts at the keyboard, which is shown at the left side of the diagram.

Terminal From A Kit

on a 4-page computer can be connected to telephone lines.

by THOMAS W. DURSTON

transmitted from the keyboard, plus the computer can also transmit its own characters to the terminal as the software requires.

How it works

The most important single circuit in the CT256 is the clock oscillator. It is a 2-MHz crystal oscillator that provides the time base for the logic, and is also used in the modulator of the acoustic coupler to provide the FSK tones. A crystal oscillator was chosen for its stability. The 2-MHz clock is divided down to provide 1 MHz, 62.5 kHz, and 15.625 kHz for logic time base. It is also used to determine baud rate (data transmission rate) for the UART. The baud-rate switch selects either 1760 Hz (110 baud X16) or 4800 Hz (300 baud X16) for the UART clock by setting a programmable counter to divide the 2-MHz clock by 1136 or 416 respectively. The modulator in the acoustic coupler works in a similar manner. Instead of setting a switch to set a programmable counter to divide by different rates, it uses the binary logic 1 or 0 of the data to derive the two divide rates.

Starting with the data path, the keyboard encodes the character by feeding a 15-kHz signal to a 4-bit binary counter that is connected to a 4-to-16 line decoder. The character keys are connected to the 16 lines according to the first 4 bits determined by the ASCII code. When a key switch is closed, and the line it's connected to is strobed, the 4-bit counter is halted. The 4-bit count where the counter stopped is the first 4 bits of the 7-bit ASCII code and the other 3 bits are encoded by a series of logic gates. After a 30-ms debounce period, a load signal is sent to the UART, where the parallel 7-bit character code is entered into registers and transmitted out serially at the selected baud rate. The serial data is sent to the modulator where it is converted into audio frequencies as described before and is fed into a speaker which transmits the FSK audio to the transmitter of the telephone handset.

When the computer returns the data or originates its own, it is received as a 2225-Hz or 2025-Hz tone. The signal is picked up by a ceramic microphone adjacent to the receiver in the telephone handset, and is amplified and converted to a low-impedance output by a JFET-NPN transistor circuit. This low-impedance circuit feeds the tape output and a two-stage op-amp active filter.

The two-stage filter removes noise and interference and provides a gain of about 400. The filter output feeds a carrier detector circuit that turns on the carrier LED, enables the transmit circuit, and enables the FSK demodulator which consists of an XR210 IC phase locked loop. The output of the op-amp filter also feeds the XR210 and the signal is demodulated into serial binary form. This serial binary data is fed into the UART and is sampled at the set baud rate. If the serial data is valid, it is converted into a 7-bit parallel format corresponding to the ASCII code for the character received.

The UART also indicates that it has new data available. Meanwhile, the receive decoding determines if the new 7-bit character is a display character or a control character. If it is a display character, it is allowed to be entered into memory, if it is a control character (bell signal, cursor control char; see table of control characters) the receive decoder inhibits memory loading and initiates the necessary operation.

Memory operation

Probably the most involved circuitry in the CT256 centers around the 5-bit (32 count) display counter and 4-bit (16 count) X-Y memory address counters. The X-Y memory address counters are both 4-bit (16 count) up-down, presettable counters, making a total combination of 256 addresses (16X by 16Y). For reference sake, the Y addresses are called lines and X addresses are called character positions (see Fig. 2 & 3). The start of the page is called "home" (see Fig. 4) and has address ϕ, ϕ (line ϕ, position ϕ). When the black "H" key (home) is depressed, it homes the data to the cursor position (right hand end of display—32nd character) and results in the X-Y address counters being at ϕ, ϕ during the 32nd character display time.

The cursor position is very important because it is during this 32nd-character display time that; new data is entered into memory, data is shifted right or left in the display, data is homed, memory is cleared, and many other timing chains are based.

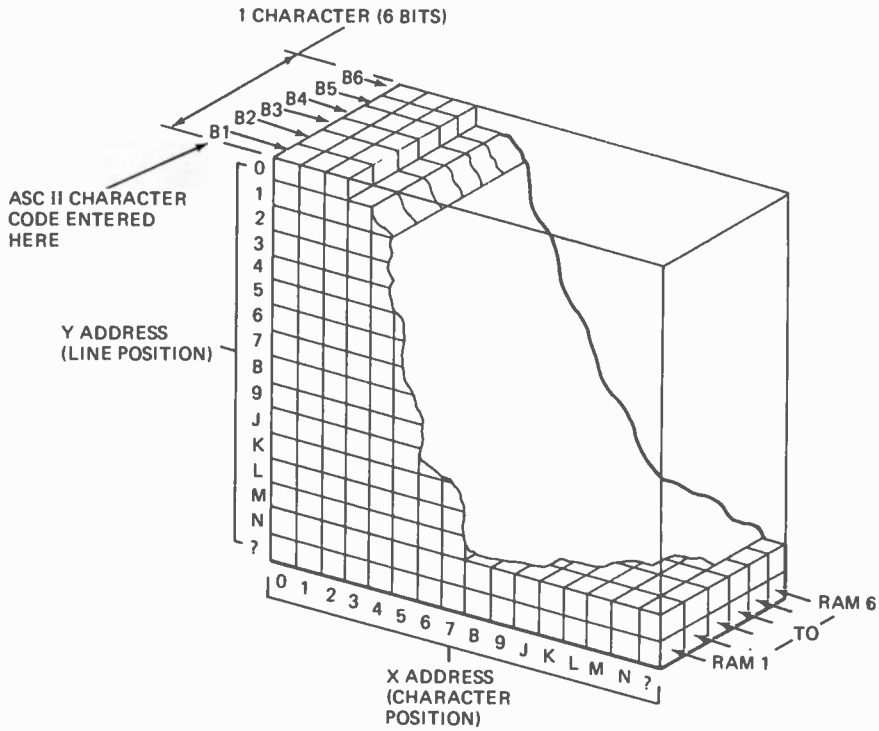


FIG. 2—MEMORY FORMAT. The 6-bit character is entered into memory in ASC11 code. The memory location is selected in accordance with the respective position on the page (line and character position.)

bits of ASCII code to locate a particular address in memory and display it in the cursor position. The first character received after the address function is initiated, selects the line number (1-16) by setting the Y address counter equal to the first 4 bits of that charac-

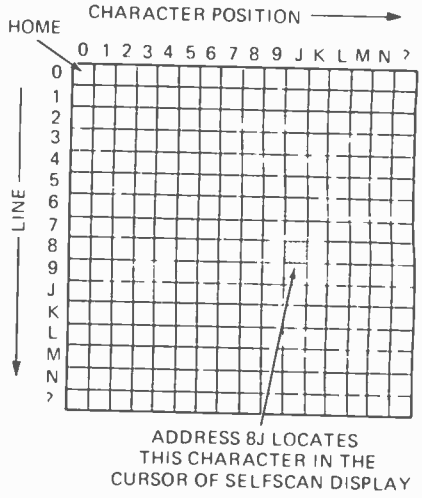


FIG. 3—MEMORY FORMAT shows the page position and character location respectively. Address 0, 0 is the "home" position on the page.

At the time when the UART indicates new data available and the 32nd-character display time starts, the read/write logic generates a write pulse for the memory. The first 6 bits of data at the output of the UART are then written into 6 RAMs (Random Access Memory) at that address. The write pulse also goes to the cursor control logic, where, upon completion of the write pulse, the X-address is incremented one position, shifting the data one position to the left on the display. The write pulse also triggers a circuit that resets the data available line from the UART.

The clear circuit, activated by either pressing the black "C" key or receiving a control "L", enters the ASCII code for a blank into all 256 positions of memory for that page. It works by holding the write circuit on and forcing the data input lines to the memory to coding for a blank. This only takes place during the 32nd-character display time during which it "homes" the X & Y counters and advances the X-counter 256 positions (one complete page) at a 1-MHz rate.

The auto transmit circuit works by depressing the black "T" key which activates logic that switches the transmit data lines from the keyboard to the data output lines from the memory. Whatever character is in the cursor position of the display is transmitted out to the computer. As that character is received back, it is re-written into the same position in memory, the data is shifted left one position and the next character in memory is transmitted.

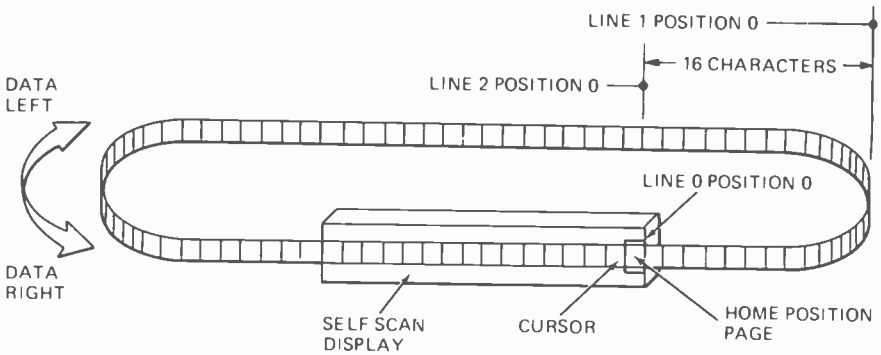


FIG. 4—PAGE FORMAT shows how the page is displayed on the Self Scan display. Each line of the page is 16 characters long and the page is displayed one line at a time.

Since the memory only stores the first 6 bits of the 7-bit ASCII code, the 7th bit must be derived by logic gating.

This is one reason why the CT256 cannot auto-transmit control characters.

The 7th bit cannot be derived for control characters, and since the memory does not receive and store them anyway, they have to be transmitted manually via the keyboard. To allow entry of control characters such as carriage return, the detection of the @ symbol will cause auto-transmit to stop and the desired character may be manually transmitted. The @ symbol is detected in the cursor position and auto transmit cannot take place unless it is shifted out by manually entering a new character.

The address function is initiated by pressing the black "A" key or by receiving a control "O". It sets up the receiving decoding to accept the next two characters and use their first four-ter's ASCII code. The second character received selects the position in the line (1-16) by setting the X address counter equal to the first 4 bits of that character's ASCII code. These two characters are used only for address location and are not loaded into memory. For Y (line) and X (position) identification see Fig. 3.

Page circuitry

The page control circuit for a multi page unit consists of two circuits for each page. The first set of circuits enables each set of 6 RAM's, making them active for the page selected; the second set of circuits reduces power to the unused pages to standby levels, reducing current drain by 75%.

The operation of the page control circuit is determined by the setting of the PAGE switch. In MANUAL, the page can only be changed by depressing the black "P" key. Pressing the black "P"

(continued on page 91)

Digital Multimeter Roundup

The digital multimeter has finally moved out of the laboratory and onto the service bench. Here's a rundown on those that sell for $300 or less.

by ROBERT F. SCOTT
TECHNICAL EDITOR

FOR YEARS THE MULTIMETER HAS BEEN the principal—and sometimes the only—test instrument used by the service technician for voltage, current and resistance measurements. Many old-timers have an almost continuous squint acquired from peering at a meter and trying to read the voltage indicated by a pointer that has banged against its pins once-too-many times.

Digital meters—presenting the metered quantities in large easy-to-read numbers—have been used in laboratories, industrial plants, etc. for years but have just recently been developed to the point that they are priced within the reach of electronic service technicians and many experimenters.

The digital multimeter, often called a dmm or dvm, offers many advantages to the busy service technician. For example, in some dmm's, range selection, polarity indication and decimal point placement are performed automatically. The indications are often large enough to be easily read from up to 20 feet away. Parallex does not exist so it cannot affect reading accuracy. The accuracy of the instrument is much greater than a typical analog vom or vtvm.

There are quite a few new dmm's in the $300 and under class that will appeal to the service technician and advanced experimenter. We are going to discuss the features and operating principles of the dmm and present the pertinent specifications of the instruments you should consider before making your selection.

How the dmm works

The analog instrument takes the metered quantity—voltage, current or resistance—and converts it into a voltage that is read on the meter in the proper values and terms. A precision voltage divider attenuates the test voltage so it is within the basic voltage range of the meter movement. The dmm is similar except that the moving-coil meter is replaced by an analog-to-digital converter whose output drives a digital display or readout.

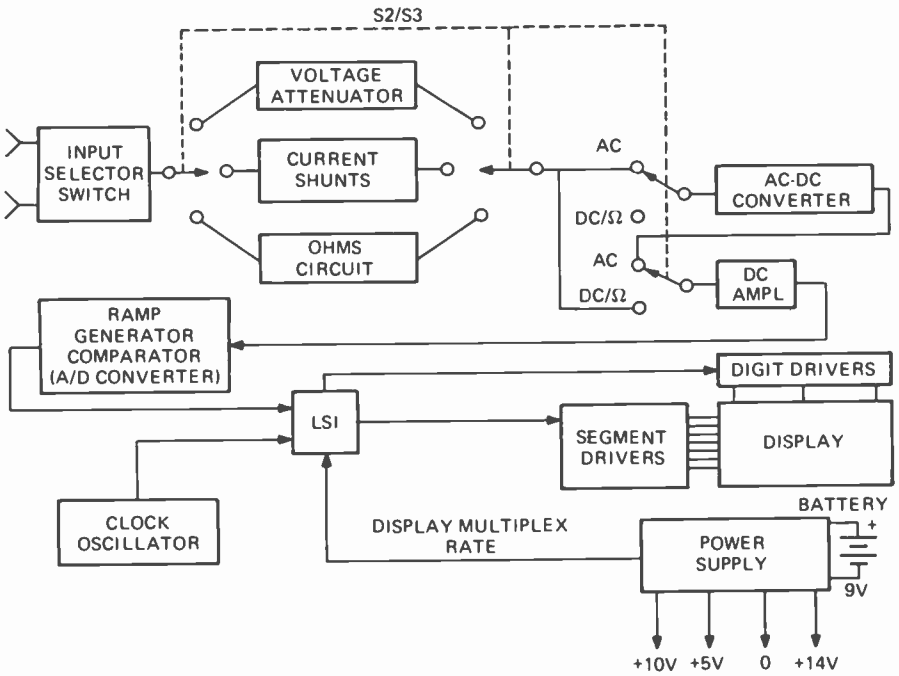


FIG. 1—BLOCK DIAGRAM OF BALLANTINE MODEL 3/24 digital multimeter. Note the basic similarities between this and an analog multimeter.

Compare the block diagram of the Ballantine model 3/24 dmm (Fig. 1) with that of your Simpson 260, Triplett 630 or similar instrument and you'll see the resemblance. The dmm is basically a dc instrument with a scaled-down portion of the input voltage applied to the display through the analog-digital (A-D) converter. Resistance is measured by passing a constant current through the unknown resistor and measuring the voltage drop across it. Current is metered by measuring the voltage drop across a current shunt. When measuring ac voltage or current, a rectifier is inserted between the input attenuator and the A-D converter.

The A-D converter is the interface between the analog dc input and the digital display device. There are a number of different ways of converting an analog dc voltage to a digital value. Among these are: voltage-controlled oscillator, single-ramp and double-ramp integration, charge balancing and successive approximation. All have advantages and disadvantages that affect accuracy, resolution, and the rate at which the display can follow or track a changing input signal. The study of A-D converters as applied to dmm's is quite interesting; but is beyond the scope of this article. If enough of you are interested, we'll cover A-D converters in a future issue.

Displays

The three types of displays in com-

mon use are LED's in both 5 × 7 dot matrix arrays and seven-segment arrangements; liquid crystals in both transmissive and reflective types and gas-discharge tubes such as the Nixie. Each type has its advantages and disadvantages.

Gas-discharge tubes generally offer brighter and larger digits that can be read from greater distances. However, they require a relatively high excitation voltage and their current drain is high enough to restrict their use to line-operated bench-type instruments. LED's are the most common type of display. They are easy to read in either format; are high-efficiency devices that operate from approximately 1.5 volt and draw about 25 mA per segment. When the display is strobed, the average power is low and long life can be expected from high-quality dry cells.

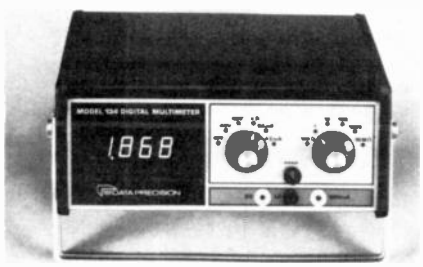
There are reports that some bench technicians complain of eye strain and fatigue after long hours of reading LED and gas-discharge displays. Too, both types tend to wash-out when viewed in bright sunlight.

Liquid crystals are the new-comer to the display field and seem to be the ideal in terms of power consumption. A liquid-crystal display draws only microwatts while an equivalent LED display will draw many milliwatts. This type of display is made in both transmissive and reflective types. The former must be backlighted which compromises the power saving gained through its use. The reflective-type display can be used in areas where high ambient light and widest angular visibility are not needed.

Battery operation

Most dmm's are line-operated with built-in batteries. Some have throwaway dry cells and others have rechargeable batteries, either installed or in optional battery packs. If you want a battery-only instrument, be sure that the batteries will last long enough for a couple of days use.

TWENTY TWO RANGES, four each for dc and ac volts and current and six for resistance are included on the *Data Precision model 134.* Its 3½-digit, 7-segment gas-discharge display incorporates 200% over-range and has a reading rate of approximately 1 per second. Voltages up to 1.5 kV rms; current



to 2 amps and resistance to 20 megs can be read. At 100% overrange, the reading is 1999. Readings above 1999 are indicated by the lighted "1" and selected decimal point. The other three digits are blanked.

The least significant digits are 1, 10, and 100 mV and 1V on the voltage ranges; 1, 10, 100 μA and 1 mA on current; and 0.1, 1, 10, 100, 1K and 10K in the resistance mode.

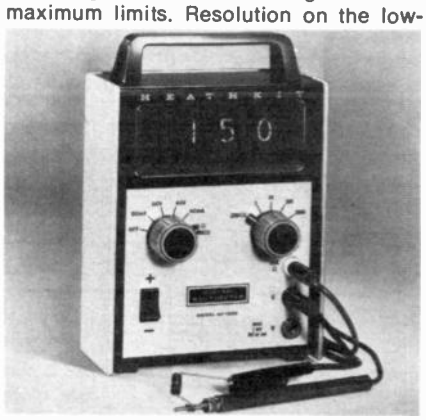
Optional isolation probe has switchable 100K isolating resistor. High-voltage probe extends range to 30 kV. 3½ × 7⅛ × 8⅞ in. 4¼ lbs. $189.

LINE-OPERATED VERSION of the *model 21* is *Data Technology's model 20.* Ranges, functions and specifications are the same as in the hand-held *model 21.*

Options include single and side-by-side rack mounts, carrying case, high-voltage probe; 100-, 115- and 230-volts ac line operation and IC sockets for quick component replacement, 2.5 x 6.25 x 9 in., 2.3 lbs. $269.

FOUR RANGES and cold-cathode readouts and indicators are used in the *Heathkit IM-1202* portable digital multimeter. This 2½-digit instrument is well within the reach of hams and beginning electronics experimenters while meeting the specifications required for many operations on the radio/TV service bench.

Its ranges are: 2, 20, 200 and 1000 Vdc; 2, 20, 200 and 700 Vrms (25 Hz to 10 kHz); 2, 20, 200 and 2000 mA dc and ac; 200, 2000, 200,000 ohms and 2 megs. Overrange is 25% on all ranges—within maximum limits. Resolution on the low-



est ranges is 10 mV, 10 μA and 1 ohm. Accuracy (full scale ±1 digit): dc volts ±1%; dc and ac current and ac volts ±1.5%; ohms ±2%.

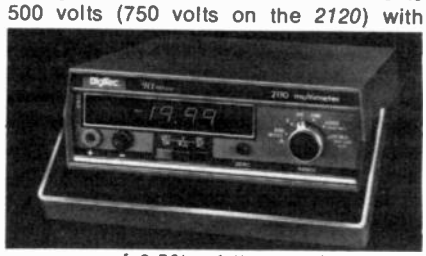
Input impedance is 1 megohm on all voltage ranges. Power requirements 110–130 or 220–260 Vac, 50/60 Hz. 7¾ ×5⅜ × 3⅛ in., 2½ lbs. $79.95.

WORLD'S SMALLEST is the claim made for the *Non-Linear Systems model LM-4,* a full 4-digit instrument with full-scale count of 10,000 on 0.31-in. red LED display elements. It measures ac and dc volts from 100 μV to 500 V and resistances from 0.1 ohm to 10 megohms and operates from the 117-volt line.

The case is 1¾ inches high, 2½ inches wide and 3¼ inches deep. Its carrying handle also serves as an adjustable tilt stand. $187.

PLUG-IN BOARDS, IC'S AND readouts for easy replacement are features of the *DigiTec model 2110* and *2120.* Internal rechargeable batteries facilitate operation independent of power lines. A built-in automatic charger keeps the batteries charged as long as the dmm is connected to the power line.

Dc voltage ranges extend from 199.9 mV to 1000 volts full scale with basic accuracy of 0.1% of the reading. Ac voltage can be measured from 1.999 to 500 volts (750 volts on the *2120*) with



accuracy of 0.5% of the reading. Basic accuracy of 0.5% of the reading is available on five resistance ranges extending from 199.9 ohms to 19.99 megs. A zero control permits nulling test-lead resistance.

Functions are selected by pushbuttons while ranges are changed with a rotary switch that includes a BATT CHK position. Input impedance is 10 megs on dcV; 1 meg shunted by 10 pF on acV. The 3½-digit display uses 0.3-in. high LED numeric indicators. Overrange blanks all numerals except the overrange "1", polarity sign and decimal point.

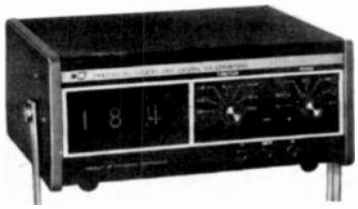
Gulton R-200 batteries operate the model *2110* a minimum of 8 hours and the *2120* 5 hours in continuous operation. Recharging takes 16 hours after full discharge.

The *2120* (not shown) has all the features of the *2110* plus five ac and dc current ranges extending in decades from 1.999 μA to 1.999 A.

Power requirements 115/230 V, 50–400 Hz; 2.5 W for the *2110* and 5 W for the *2120.* Size 2.43 × 7.25 × 7.95 in., 2 lbs. less batteries. *Model 2110* $219, *2120* $275.

AUTOMATICALLY POSITIONED decimal point, 100% overrange capability and fool-proof out-of-range indications are features of the *B & K Precision model 281*. On this 2¼-digit instrument, out-of-range is indicated when the first digit remains on while the second and third digits are off.

Ac and dc voltages are measured on 100 mV, 1.00, 10.0, 100V and 1.00 kV ranges. Accuracy is ±1% of reading



±1 digit on dc and ±1.5% of reading ±1 digit on acV. Current measurements (ac and dc) are in 100 μA, 1.00, 10.0 ano 100 mA and 1.00 amp ranges with accuracy of ±1.5% of reading ±1 digit. Frequency response is 20 Hz to 1 kHz.

Seven decade resistance ranges (10 ohms to 10.0 megohms) provide accurary 2% of range to 1 megohm and 3% of range on 10 megohms. The instrument provides 100% overrange on all functions.

The *281* operates from 117 Vac, 15 W. 3½ × 7 × 9 in. 5 lbs. $170.00.

CAPACITANCE READING CAPABILITY in a hand-held dmm is a unique feature of the *Data Technology model 21*. It is a 3½-digit instrument powered by four internal rechargeable batteries that provide up to several weeks of intermittent usage. It comes with a plug-in battery charger that can be specified for 100-, 115- or 230-volt operation. Battery charge life is extended by the use of PUSH-TO-READ switches.

Voltage ranges are 2, 20, 200, and 1000 volts dc and peak ac with 1-mV resolution. Resistance ranges are 2K, 20K, 200K and 2 megohms. Capacitance is read in four ranges from 2 to 2000 nF (.002 to 2.0 μF) with resolutions of 1, 10, 100 and 1000 pF.

Accuracy on resistance and capacitance is ±0.15% of reading +0.05% of full scale; ±0.1% of reading +0.05% of full scale on dcV and 0.5% or reading +0.1% of full scale (50 to 500 Hz).

The *model 21* slips into a pocket or into a handy carrying case that clips onto a belt. It is 6.8 x 3.25 x 1.75 in. and weighs only 12 oz. $269.

Reading specifications

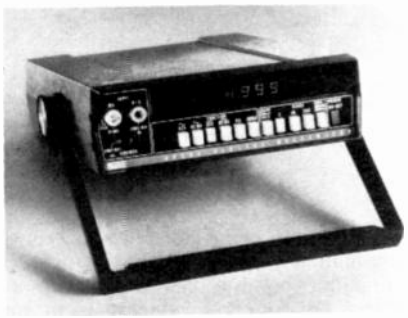
The ½ digit: Dmm's are generally specified by the number of digits (numeral indicators) in the display. Each digit is capable of displaying any numeral from 0 to 9. A 3-digit instrument will have a maximum reading of 999 and a minimum of .001. If it has 1, 10, 100 and 1000 volt ranges, it reads maximums of .999, 9.99, 99.9 and 999 volts, respectively.

Each digit added to a display increases circuit complexity and cost proportionately. Manufacturers found that they could improve the *resolution* (the smallest change in the quantity being measured that will produce a change in the display reading) of their instruments at little increase in circuit complexity or cost by adding a left-hand digit that displays only the numeral "1." This "1" is called the half-digit. Thus, a 3½-digit instrument can display 1999.

Overrange is an extension of the half-digit technology and is a means of extending the readings beyond what would be full-scale on an analog instrument. Most multimeters have ranges of 1, 10, 100 and 1000 or similar decades. Now, suppose that we want to measure the precise voltage of a standard 1.5-volt dry cell. Using an analog instrument, we would have to use the 10-volt range and would not be able to read the voltage with any degree of accuracy. With a dmm, we would use the 1-volt range. The applied voltage would be greater than the range selected. The instrument would sense an over-range; the half-digit "1" would light and the voltage

NOISE COMPONENTS on the signal being metered are removed by a two-pole filter before being processed by the A/D converter in the *Fluke model 8000A*. It is a compact 3½-digit instrument featuring pushbutton range and function selection, automatic polarity switching, a self-locating decimal point and self-zeroing to eliminate offset uncertainties. The basic dmm is designed around ±0.2 and ±2.0 Vdc and has twenty six ranges and six functions.

The *8000A* measures ac and dc volt-



ages from 100 μV to 1199 V; current from 100 mA to 1.99 A; and resistance from 100 milliohms to 19.99 megs. Dc voltage and current are measured with accuracy of ±0.1% of reading +1 digit and ±0.3% of reading +1 digit, respectively. On ac (45 Hz to 10 kHz) voltage accuracy is ±0.5% of reading + 2 digits. Current measurements are ±1% of reading +2 digits (except on 2000 mA where frequency is limited to 3 kHz). In the range of 10 kHz to 20 kHz, voltage accuracy is ±1% of reading +2 digits. Resistance accuracy is ± 0.2% of reading +1 digit on all ranges except: ±0.5% of reading +1 digit on 20-meg range.

Input impedance is 10 megs on dcV and 10 megs shunted by 100 pF on acV. Optional probes extend measurement capabilities to 30 kV dc, 200 amps dc and to 500 MHz on acV.

The Fluke dmm is available in somewhat more expensive options. The *8000A-01* includes an optional rechargeable battery pack providing over 8 hours of portable operation. The *8000A-02* has a digital printer output; the *-05* features a 10-amp current range and the *-06* has *low ohms* (2 and 20 ohms) ranges.

The *8000A* operates from 100–115 and 230 Vac, 50–400 Hz, 2 W. 2.52 × 8.55 × 9.9 in., 2.75 lbs. $299.

TRUE PORTABILITY AND LAB precision are claimed for the 4½-digit *Data Precision model 245*. It is about the size of an Instamatic camera and even includes a wrist strap. Voltage, current and resistance are read on 21 ranges with 100% overrange. It comes with carrying case, wrist strap, test leads and a battery module that includes rechargeable batteries, battery charger and line cord.

When operated on the ac line, the batteries remain on charge whether the dmm is turned on or off. When disconnected from the power line for portable or field use, the batteries last at least 6 hours before recharging is required. Recharging takes about 12 hours.

Ranges: Dc volts 1.000 to 1000 with 100% overrange. Input impedance 10 megs on three highest ranges; over 1000 megs on 1.000-volt range. On ac, the ranges are the same as on dc

except on the 1-kV step where overrange voltage is limited to 500 volts. Ac input impedance is 1 megohm shunted by 50 pF or less. Maximum rms input is 500 V, 30 Hz to 10 kHz, above 10 kHz it decreases linearly to 200 V at 50 kHz. Settling time (to settle within ± 0.1% of final reading with full-scale input) is 2.5 sec.

Current (ac and dc) 1 mA to 1 A in four decade ranges with 100% overrange. Resistance: 1K to 10 megs in five decade steps. Least significant digit on lowest range is 1 milliohm. Maximum open-circuit voltage is 3.5 V.

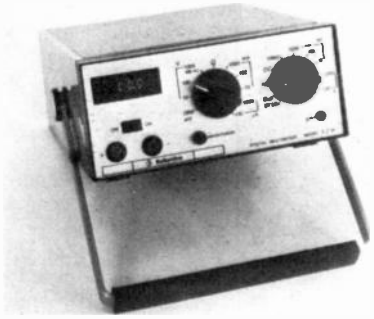
Operates from 105-125-volts, 47–63 Hz. 5½ × 1¾ × 3½ in. 1.3 lbs. $295.

could be read with three-place accuracy —1.470 for example—an impossibility with an analog vom.

Accuracy of an analog vom is usually specified as a percentage of the full-scale reading—generally 2 to 3%. Parallax, pivot wear, needle unbalance and other deficiencies of the moving-coil meter can further degrade accuracy. On the other hand, the accuracy of a dmm is specified as ± a percentage of the *reading* plus 1 digit. A reading of 1.000 volt would have a possible error of (1.000 × .001) + 1 or ± .002 volt.

Auto-ranging is a feature of some dmm's. The operator selects the desired function (volts, current, resistance, etc.) and connects the test leads to the point or component being mea-

FULL 3-DIGIT LED DISPLAY is used on the *Ballantine 3/24* dmm. Two rotary panel switches provide 25 operating ranges including one for battery check. A flashing left-hand digit and an indication of less than 200 indicate a reliable reading between 1000 and 1200. Automatic polarity indication when measuring dc voltages and current. Ranges are: 1000 mV, 10, 100 and 1000 Vdc; 100 and 1000 μA, 10, 100 and 1000 mA dc and ac; 1000 mV, 10, 100 and 500 Vac; 100, 1000, 10,000, 100,000 ohms and 1 and 10 megohms.



Accuracy is ±0.2% of reading +1 digit on 1000 mV dc, ±0.5% of reading +1 digit on 10, 100, 1000 Vdc and the five current ranges; ±1% of reading +2 digits on acV; ±1.5% of reading +2 digits on ac current and ±1% of reading +1 digit on all resistance ranges.

The optional *10850A* peak detector can be used to measure sinewaves to beyond 500 MHz. Maximum input signal is 30 Vac. The optional *10800* HV probe measures dc up to 30 kV.

The *3/24* operates from any one of four dc power sources: NEDA type 1603 dry cell battery, any external 6.2–10-volt source delivering 50 mA, a voltage-dropping network or the *Ballantine 32401* dc adapter permitting operation from 9.8 to 34 volts dc at 10 to 100 mA, depending on the input voltage and setting of the display brightness control. Ac operation is from the optional *32402A* plug-mounted supply requiring 100 to 135 Vac at 3 watts. The unit stores in the dmm's battery compartment. A *32403A* rechargeable NiCad battery supply powers the dmm for 16 hours and incorporates a charger that restores full charge in 16 hours. Fits in battery compartment and operates from 100–125 and 200–250 Vac, 48–420 Hz.

The *3/24* is 5.5 x 2.4 x 7.1 in., and weighs 2 lbs. with battery. $195.

ANALOG OUTPUT AND DISPLAY are features of the *Simpson 360* that are unique in dmm's in its class. The analog output terminals of the 360 provide 1 Vdc (open-circuit) corresponding to a digital reading of 1000. This analog signal voltage can be used to drive a graphic recorder.

The analog meter is a zero-center instrument that is handy for peaking, nulling and making other adjustments on circuits evolving rapidly varying signals.

The *360* is a 3½-digit instrument employing 7-segment LED display elements. It can operate from 117 or 240 Vac, 50–400 Hz lines. For complete isolation from power lines or in cases where ac power is not available, rechargeable NiCad batteries provide up to five hours

of continuous operation. Recharging is automatic when the line cord is plugged in and the function selector is in the BATT CHRG ONLY position. A LED on the panel shows when the battery is being charged.

The function selector switch has four positions: OFF disconnects all power from the internal circuits; BATT CHRG ONLY fully charges the battery in 16 hours; DC OHMS connects the appropriate input jacks for measuring dc current, voltage and resistance; depending on the setting of the range selector. AC connects the appropriate panel jacks to the ac voltage or current metering circuits selected by the range switch.

Voltage ranges are from 200 mV to 1000 Vdc and 600 Vac. The 0–200 and 0–2000-ohm resistance ranges are "low power" with a maximum 150 mV open-circuit. The other ranges are 20K, 200K, 2 megs and 20 megs full scale.

Input jacks—20 μA, 200 μA, 2 A and 10 A—are used for current measurements with full scale values selected by the range switch with accuracy ±0.5% of the reading +1 digit (except on 2 A and 10 A ranges where accuracy is ±1% of reading + 1 digit). Six ac ranges cover from 200 μA to 10 A. Accuracy ±1.0% of the reading +1 digit through 200 mA; ±2.0% of reading +2 digits on 2- and 10-amp ranges.

Size 7.2 × 5.4 × 3.75 in., 4.5 lbs. $295.

CONDUCTANCE AND LEAKAGE current are two unique features of the *Tekelec 357 Multex* dmm. Like the *TA 355* and *TA 356*, the *TA 357* has optional transmissive or reflective liquid-crystal readouts, ZERO control and Touch-n-Hold probe. There are six decade voltage ranges covering 0.1999 volt to 19.99 kV. Input impedance is 10 megohms on

the first three ranges and 1000 megohms on the 1.999- and 19.00-kV ranges with the 100:1 HV probe. An ON-OFF switch displays the ac line voltage when the ac-volts function is selected.

Current (ac and dc) is metered in 0.1999, 1.999, 19.99 and 199.9 mA ranges. Conductance is mhos is measured in four ranges: 2 × 10^{-3}, 2 × 10^{-5}, 20 × 10^{-6} and 200 × 10^{-6}. Leakage current ranges are 10 pA, 100 pA and 1 nA. Size 2⅜ x 5¼ x 9½ in. $179.

ITS 3½-DIGIT DISPLAY makes the *B & K Precision model 282* the "Big Brother" of the *281*. It reads voltages in four decade ranges from 1.000 to 1000 volts ac and dc. The 100% overrange feature permits maximum readings of 1.999, 19.99, 199.9 and 1999 on all ranges. On the 1-, 10-, and 100-Vdc ranges accuracy is ±0.5% of the reading ±1 digit and ±1.0% of the reading ±1 digit on the 1-kV range.

On ac volts (50 to 200 Hz), accuracy is ±1.0% of the reading ±1 digit on the three lowest readings and ±1.5% of the reading ±1 digit on the 1-kV range. Accuracy (50 to 1000 Hz) is ±1% on the 1-, 10- and 100-V ranges and ±1.5% on

the 1.5-kV range. Response is ±0.5 dB, 1000 to 10,000 Hz on the 1- and 10-volt ranges; ±1 dB, 1000–10,000 Hz on 100-V range and 1000 to 2000 Hz at 1 kV.

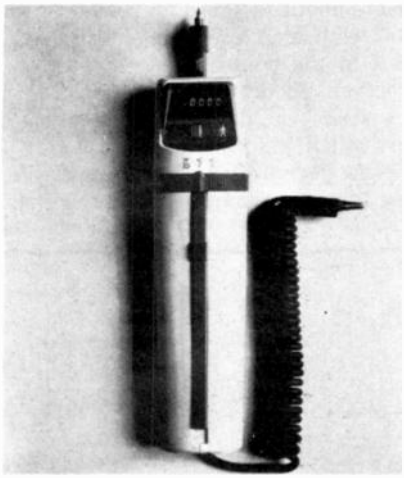
Resistance is measured in six decades from 100 ohms to 10 megohms. Accuracy is ±1% of reading ±1 digit, 100 ohms to 1 megohm; ±2% of reading on 10-meg range.

The test probe has a selectable 100K resistor that is used in making measurements in high-impedance and high-frequency circuits. This resistor, in series with the 10-meg internal voltage divider causes a —1% error in the reading. When precision is needed, increase the meter reading by 1%.

Operates from 105-125 Vac, 50-60 Hz. 3½ × 7 × 9 in., 3 lbs. $200.

BUILT IN A PROBE, the *Hewlett-Packard model 970A* has automatic ranging, zero and polarity indication.

The voltmeter ranges are 0.1, 1.0, 10, 100 and 1000 volts with 500 V dc and ac maximum input. On dc the accuracy is ±0.7% of the reading +0.02% of the range. On ac, accuracy (1 V to 1 kV) is ±2% of the reading +0.5% of the range —from 45 Hz to 1 kHz. From 1 to 3.5



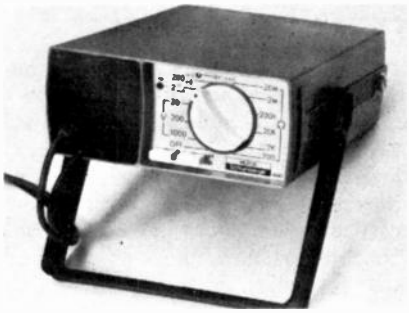
kHz, accuracy is ±3% of reading +0.5% of range. Five ohmmeter ranges cover from 1K to 10 megs with accuracy of ±1.5% of reading +0.2% of range.

Accessories include 5-range dc and ac ammeter adapters measuring 100 μA to 1 A fullrange, an rf probe that adds 100 kHz to 500 MHz to the ac measurement range of the *970A*.

Size 6½ × 1¾ × 1¼ in. 3 lbs. $275.

FIVE MODELS in the *Weston series 4400* of dmm's are within the $300 limit set for this listing. They vary in accuracy, number of ranges, functions and the type of operation. They are all 3½-digit instruments. The *4440, 4442* (shown) and *4443* are self-contained portables with rechargeable battery packs that deliver up to twelve hours of continuous power. The *4448* and *4449* are for use on 117 Vac, 60-Hz only.

Models *4442* and *4449* have twenty ranges covering from 20 mV to 1 kV ac and dc, 200 ohms to 20 megs plus 199.9



μA and 1.999 mA dc and ac current ranges. The *4443* measures only dc volts and current and resistance in the same ranges as the other instruments in the series.

All instruments in the *4400 Series* are 2.25 × 5.45 × 7 in. and weigh less than 2.5 lbs. Prices range from $220 for the model *4448* to $275 for the *4442*.

sured. The dmm automatically selects the correct range and positions the decimal point to give the most accurate reading.

Now that we've had a look at the dmm, let's take a look at the pertinent specifications of dmm's in the $300 and under range.

MANUFACTURERS

Ballantine Laboratories
PO Box 97
Boonton, NJ 07005

B & K, Div. of Dynascan Corp.
1801 W. Belle Plaine Ave.
Chicago, IL 60613

LIQUID-CRYSTAL DISPLAYS using field-effect 7-segment devices are featured in the *Tekelec model TA 355, TA 356* and *TA 357* dmm's. The *TA 355* bench model and the *TA 356* portable dmm have five functions, 25 ranges with pushbutton range and function selectors. Sensitivity is 100 μV on ac and dc voltage, 100 nA ac and dc and 0.1 ohm.

The standard displays are transmissive types—black on a white background. The optional reflective displays are black on a grey-green background. The ZERO control is a screwdriver adjustment on the *355* and a thumb-wheel control on the *356*. Range-to-range shift is 1 digit, maximum. The reading rate on the portable is fixed at 3 per second.

A 3-position rocker switch on the *355* selects 3 readings/second, 1 reading/second or "hold" the reading indefinitely.

The *TA 356* operates from internal rechargeable NiCad batteries with a life of about 6 hours per charge with the transmissive display and 8–10 hours with the reflective display. The separate power supply/battery charger is standard for either 117 V, 60 Hz or 230 V, 50 Hz.

The *TA 355* can be specified to operate from either 117 Vac, 60 Hz or 230 Vac, 50 Hz. Interchangeable NiCad batteries and charger/ac supply are optional.

Dc and ac voltage ranges are 0.1999, 1.999, 19.99, 199.9 and 1000 volts. Current ranges are 0.1999, 1.999, 19.99, 199.9 and 1999 mA. Resistance ranges are 0.1999, 1.999, 19.99, 199.9 ohms and 1.999 megohms.

Options are Touch-n-Hold probes and BCD printer output (*TA 355* only). The *TA 355* is 3½ x 8½ x 12¾ in.; the *TA 356* is 2⅜ x 5¼ x 9¼ in. $289 each.

Dana Laboratories
2401 Campus Drive
Irvine, CA 92664

Data Precision Corp.
Audubon Rd.
Wakefield, MA 01880

Data Technology Corp.
2700 Fairview St.
Santa Ana, CA 92704

DigiTec (United Systems Corp.)
918 Woodley Rd.
Dayton, OH 45403

John Fluke Mfg. Co.
PO Box 7428
Seattle, WA 98113

Heath Co.
Benton Harbor, MI 49022

Hewlett-Packard Co.
1501 Page Mill Rd.
Palo Alto, CA 94304

Keithley Instruments Corp.
28775 Aurora Rd.
Cleveland, OH 44139

Non-Linear Systems
PO Box N
Del Mar, CA 92014

Schneider Electronics
11 Riverside St.
Medford, MA 02155

Simpson Electric Co.
853 Dundee Ave.
Elgin, IL 60120

Tekelec, Inc.
31829 W. La Tienda Drive
Westlake Village, CA 91361

Weston Instruments
614 Frelinghuysen Ave.
Newark, NJ 07114

A TEMPERATURE RANGE of –50°C to +200°C is a unique feature of the *Digitest 610*, a product of *Schneider Electronics, Inc.* It is a 4½-digit instrument with four piano-type function keys —for temperature, resistance, voltage and current—along the right edge of the case and six range keys across the bottom. It operates from built-in NiCad batteries and from 117 or 220 V, 50–6- Hz. A BATTERY-TEST function is included.

Resistances from 0.1 ohm to 5 megs are measured in five ranges. Ac and dc currents from 100 nA to 1 mA are measured in one range; voltage from 100 μV to 1 kV in four ranges.

The *Digitest 610* is 3.35 × 4.73 × 9.06 in., 3.5 lbs. with batteries. $295.

(Product Listing continues on page 81)

THINGS ARE GOING DIGITAL ALL OVER the place. Aside from the advantage of getting a definite figure for a given reading, the digital-readout instruments have the advantage of high accuracy. A lab instrument can be as accurate as 0.002%, and field type instruments are now in use at 0.2% and even better.

There are places where the old-fashioned D'Arsonval meter still has a slight advantage. It is easier to see a peak in a reading with a meter-needle, or sudden current-surges, etc. However, for use in labs, R&D, and service work, the precise figures displayed by the digital readouts is definitely better. In many modern circuits we must be pretty accurate; transistor voltages, etc. The digital readout gives us our measurement as "10.75 volts" or whatever is called for. (It is slightly disconcerting to some old goats to see such a reading displayed as "10.7543 volts"! It takes a little practice to learn to ignore the "LSD" which is not a chemical but "*L*east *S*ignificant *D*igit"!)

Digital Instruments For Electronics

by JACK DARR
SERVICE EDITOR

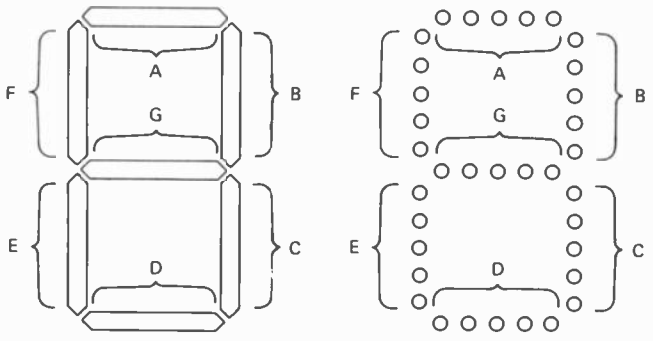


FIG. 1—SEVEN-SEGMENT DISPLAYS using LED's. a—Shows the bar type, and b—The dot type. Five dots equal one bar.

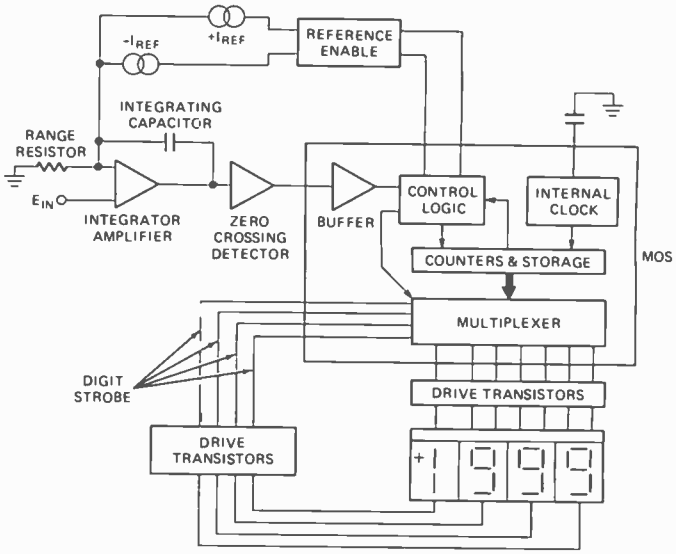


FIG. 2—DIGITAL METER CIRCUITRY using MOS IC's and LED display. Display units light in sequence, but so fast that there's no flicker.

How they work

Digital readouts are made with several different types of display units. The original was the Nixie tube made by the Burroughs Co. It is a cold-cathode tube like a neon lamp. It has a common anode, and ten cathodes—0 through 9 (in the most common type; they can be made with letters, etc.). Each cathode is switched on to display the digit.

The latest thing is a light-emitting diode (LED) readout. These are mostly of the GaAs type, and emit red light with only a very small amount of voltage and current (other materials are used to produce green or yellow readouts). There are two major types: the dot and the "seven-segment" type. with seven bars. These are arranged in a pattern like Fig. 1. To make an "8", all bars are activated. To make a "3", bars A, F, G, E and D are energized, and so on.

The LED dot displays work just like the 7-segment bar type, but they use sets of four or five individual LED's to make the equivalent of the bar. Liquid-crystal displays have been used in some instruments, but there are still some drawbacks—visibility to name just one. As a result, they're not quite as common as the others.

The control circuitry

All of these readouts use a control system which is basically similar. Starting at the display unit and working back toward the input, we go through a Display Driver. This is a set of solid-state switches which controls the illumination of the desired segments of the display. It is fed by a Decoder. These two circuits (decoder and display driver) are often combined in the same IC. It decodes the BCD (Binary-Coded-Decimal) signals from the Memory-Latch, and converts them into signals to actuate the display.

The Memory-Latch is fed by the Decade Counters; we'll trace this out in a moment. The main difference between Nixie and LED readouts is the voltage. Nixies use about 100 volts, LED's about 15 volts. So, LED's work well with the low-voltage TTL IC's used in the control circuitry. LED's, however, do draw more current than the Nixie type display and do not use very much less power.

Now let's follow the control process through, from the counter inputs. The decade counters do just that; count to ten. Their input will be a series of digital pulses, usually BCD, from the input of the instrument. Each of these counts up to 9 pulses, then transfers the tenth pulse to the following decade counter and starts over. The counters are connected in series; each one controls one of the digital readouts. The first operates the "units" readout, the next the "tens", next the hundreds, and so on and on.

Their input signal is controlled by a "clock oscillator"; its high frequency has been divided down to get a longer sampling period. A sampling circuit controls the gating of the input signal into "slices" of a given time-duration,

say 1.0 ms. If we're counting a frequency, these circuits will slice off a 1.0 ms sample, square it into square waves, and feed it to the decade counters.

The counters receive the input for the period of time selected by the instrument controls. While doing this, the first decade counter counts up to 9, then passes the next pulse along to the tens counter. This one takes the first 9 counts, and then passes along a "100" count to the following counter. This can go on as long as necessary, depending on the number of units (digits) in the display, and the signal being counted.

At the end of the counting or sampling period, the total number of counts is present on the string of counters, as logic highs or lows at their terminals. Next, a "transfer pulse" commands the counters to send the stored numbers along to the Memory Latch, and reset themselves to zero. These memory latches transfer the stored signals to their outputs when the transfer line goes to a logic low, they "remember" the figure, and hold it. This is then transferred to the decoder-drivers.

These decode the BCD signal, which is on four lines (called A, B, C and D to avoid confusion with figures (and we'll have enough confusion as it is). The "truth-table" for the decoders commands them to deliver one output (that is, the output signal which will light only one digit of the display) for given combinations of high and low on the inputs. A Nixie driver will have the four logic inputs, and ten individual outputs, one for each digit. The one corresponding to the desired digit will go low (grounding the proper cathode in the tube) and all others will remain high. In a Nixie display, all of the tubes light at the same time.

For LED displays, the same basic circuitry is used. But there can be some differences in the actual operation. For example, the Weston panel-meter unit, Model 1221, in Fig. 2, has a four-digit LED display. This one uses a seven-segment display.

A mildly unusual method of lighting the LED's is used. The count comes through the logic, the multiplexer unit, and goes to seven lines leading to the display. All lines are connected to each LED unit, in parallel. To display different figures, the entire display is "strobed" by the second set of drive transistors; in other words, each unit is flashed in sequence, by the strobe signal from the multiplexer. So it displays only the digit which its logic signals tell it to.

The scanning is so fast that the display seems to be continuously lit; in this instrument, at a 100-Hz rate. This kind of switching and scanning is easily obtained with low-voltage TTL logic units, since it takes only a few volts to bring an LED to full brilliance.

Needless to say, this kind of work can only be done by liberal use of integrated circuit technology. In many of the new instruments, even these are being supplanted by large scale integrated MOS IC's (LSI-MOS). Fig. 3 shows the "works" of a Weston Model 1230 bipolar panel-meter. Fig. 4 shows a front view of the Model 1220 and 1221, which does the same thing with only a single LSI chip! You can do it with discrete transistors but you'll need a U-Haul truck to carry it around!

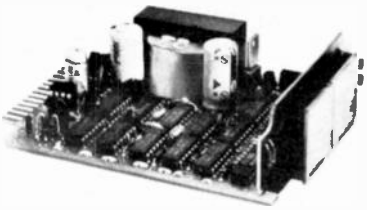


FIG. 3—INSIDE A DIGITAL PANEL METER. This unit is a Weston Model 1230.

FIG. 4—A SINGLE IC does all the work in this digital panel meter.

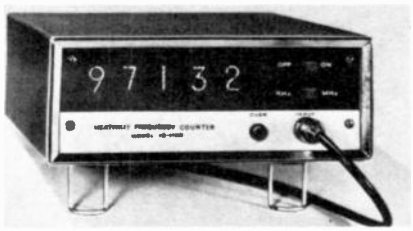


FIG. 5—HEATHKIT MODEL IB-1100 frequency counter uses Nixie type readout.

FIG. 6—THIS FREQUENCY COUNTER has eight digits in its readout anc goes out to 120 MHz.

FIG. 7—A FREQUENCY COUNTER CAN be used to check the frequency of an amateur radio rig.

FIG. 8—HIGH-FREQUENCY MEASUREMENTS can be made with instruments like H-P 5354A. It goes to 4 GHz.

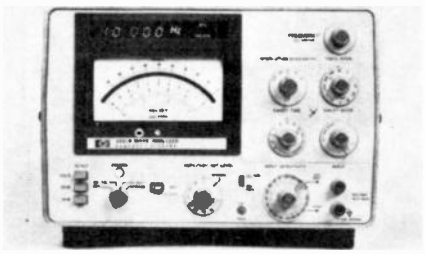


FIG. 9—COMBINATION INSTRUMENT is a wave analyzer and a selective voltmeter. Interesting combination of digital meter and analog meter.

Typical instruments

Now let's look at a few of the ways in which a digital readout can be used to improve the usefulness of an instrument. We have always had instruments which were potentially very accurate; now we have a readout that can match this. For the first, look again at the Weston Digital Panel Meter in Figs. 3 and 4. This is a simple (On the outside, anyhow!) black box.

It is basically a voltmeter. By selecting values for built-in range resistors, it can be anything from a 0 to 100-mV voltmeter to a 1000-volt meter. Dc current from 10 mA (full-scale to 100 mA can also be read. Ac voltages

and currents can be read with an ac adapter, Model 9744.

Data can be provided to make the model 1220 or 1221 read engineering units—feet, pounds, rpm, pressure, and so on. The only difference between the two models is the power supply; the 1220 uses 5.5 volts dc, and the 1221 is 117-volt ac powered.

Frequency-countnig is one of the tricks that digital readouts do well. The Heath Co. has four models, the IB-1100 (5 digits, to 30 MHz), the IB-1101 (5 digits, to 100 MHz +), the IB-1102, (8 digits, to 120 MHz) and the IB-1103 (8½ digits, to 180 MHz). These are shown in Figures 5 and 6.

Figure 10 shows the H-P 8640B vhf signal generator, with a digital readout that can be used to show the output frequency, or to read the frequency of an external signal. It will go from 450 kHz to 550 MHz, on AM or FM. The D'Arsonval meter on the panel will also do tricks! It read AM modulation percentage, FM peak deviation or output level in dBm or volts, and it is an autoranger. No switching is needed; it adjusts itself.

Figure 12 shows an H-P Model 5270A Automatic Capacitance Bridge. It has a dual digital readout; one reads the capacitance, and the other the dissipation factor or conductance, whichever is desired, simultaneously.

to a signal that is drifting or changing in frequency. Indicator lights on the panel tell whether the circuit is locked or unlocked to the signal.

Figure 11 is the front panel of an oscilloscope. Innocent-looking enough, isn't it? It isn't. This is a *digital oscilloscope*, the Nicolet Instrument Corp. Model 1090. The difference lies in the way the signal can be displayed. A standard analog scope displays the instantaneous waveform. Storage scopes can hold it, on the special screen of the crt. In the Model 1090, the signal is not fed to the crt. It goes, instead, to a memory bank with a capability of storing 4096 words of 12 bits each.

To display the recorded waveform

FIG. 10—VHF SIGNAL GENERATOR (450 kHz to 550 MHz) has digital readout to show what frequency signal it is producing.

FIG. 12—AUTOMATIC CAPACITANCE BRIDGE has a dual digital readout.

FIG. 14—AUTORANGING FREQUENCY counter by John Fluke Company uses LSI MOS IC's.

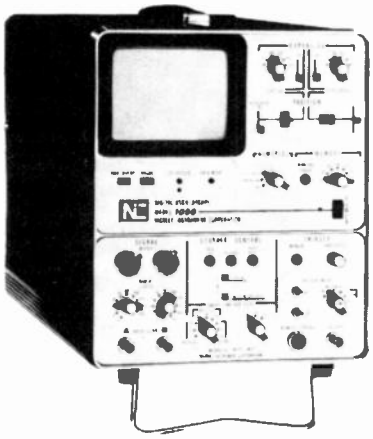


FIG. 11—DIGITAL SCOPE made by Nicolet Instrument converts visual signals into digital code and then remembers the code so it can display the remembered waveform on demand.

FIG. 13—ELECTRONIC STOP WATCH by TAFCO is a different kind of digital instrument.

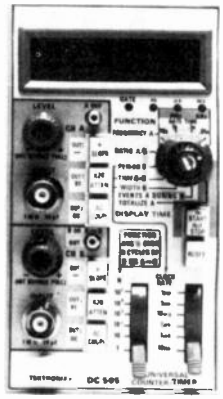


FIG. 15—UNIVERSAL COUNTER-TIMER from Tektronix.

Hewlett-Packard makes a Model 5307A counter. It is basically a frequency counter, but with the proper transducers can be used for many measurements; vibration, shock, transients, and so on. The Model 5307A is a high-resolution type.

Figure 7 shows another use for a frequency counter. Here, the Hewlett-Packard Model 5382 is being used to check frequency on an amateur rig. This would be the height of something or other to me! Carrier frequency can be accurately read to within 10 Hz!

Figure 8 shows an H-P Model 5354A counter. It will go to 4 GHz, and lock automatically on pulse-trains, as well as CW.

Figure 16 is another capacitance meter. This one is the H-P Model 4282A High Capacitance Meter. The unusual thing about it is its top range; it will go to ONE FARAD. (When I first went into this business, one Farad was literally an inconceivable quantity.) The 4282A will make other handy measurements too: the internal capacitance of a battery; capacitance of a transistor, and so on.

Figure 9 shows an interesting combination instrument; the H-P 3681A Wave Analyzer and Selective Voltmeter. Tuned to a known frequency component of a signal, this instrument will read it to five-digit accuracy, or 1.0 Hz. It has afc which allows locking it

the controls are adjusted, and the waveform is repeated indefinitely. Crosshair vertical and horizontal lines on the display can be adjusted to intersect any part of the waveform. When this is done, by pressing the COORDINATES button under Numerics, the time since the trigger is shown on the bottom of the crt screen in figures, at the left side. On the right side is displayed the voltage of the waveform at that point, also in figures. By adjusting the controls, any point along the whole length of the 4096-word recorded waveform may be frozen and studied. One engineer told me that this was equivalent to a scope with a trace *twenty-two feet* long.

Nicolet Instruments also offers their Model 93 plug-in for their scope. This has a dual channel input. Either input may be recorded in the memory bank, at will. Note the STORAGE CONTROL pushbuttons in the center. By pushing HOLD NEXT the memory records the waveform that comes along after the next trigger signal. HOLD LAST records what followed the last trigger. LIVE shows that waveform as it is actually taking place, in real time. The Model 93 plug-in will even display the stored information while watching live signals, at the same time.

Figure 13 shows still another use. This is an electronic stop-watch, with a digital readout. Using a crystal-controlled clock, it can be used in two ways; for timing the overall time of an event, and also for checking lap times, etc. *without* losing the overall count.

Figure 14 is an autoranging counter from the John Fluke Co. It will go up to 80MHz, and count as low as 5 Hz. This versatile instrument is also made possible by LSI chips.

Figure 18 shows one of the numerous combinations of instruments possible in Tektronix's new TM-500 series. It shows an SG-503 oscillator, a DC 504 Counter-Time and a DM-502 Digital Multimeter, in a 3-unit Mainframe. The power supply for all three is provided by the mainframe. From the same well known company, another unit in the same series, with a slightly different form of digital readout, is a dc power supply. It is very tightly regulated, and the exact voltage output is shown on the three-thumbwheel control — a special kind of "digital readout".

Tektronix also make a 550-MHz Frequency Counter, with digital readout, plus indicator lamps to make sure you know where you are in the band. Fig. 15 shows a Model DC-505 "Universal Counter-Timer", which will do so many things that I'm not even going to try. Check that panel.

A novel approach to the use of a scope as well as a digital meter can be yours mounting a DM-40 DMM on top of a 465 portable Oscilloscope. Now, many things can be done. For only one, you can read the time interval between any two points on the waveform; this is shown on the digital readout in whatever units are needed. Accuracy of this is within 0.1%.

A typical use of the plug-in concept of the TM-500 Series is in a Medical Instrument Calibration System; it can be used for calibrating EKG, ECG, Crash-carts, and many other types of medical electronic instrumentation.

Figure 17 shows an unusual digital readout application. It is a Tektronix DD-501 Digital Delay. To read any desired count (for applications such as events-counting, etc.) you set the figures on the thumbwheel dials. When the number of events reaches the preset count, the DD-501 puts out a trigger pulse, for an oscilloscope or any other type of triggered instrument.

A well-known name in the service instrument field, the Simpson Electric Co., makers of the famous old 260 vom, also shows up in the digital field. Figure 19 shows an instrument that might be called "Son Of 260": It's the digital vom, Model 360. There is also a "lay-down case" type, the Model 460 in the same line. The same company also makes a digital panel-meter (Fig. 20). This basic instrument can be made to read almost any quantity desired, with a few simple changes. This is the Model 2830.

Last but not least, we see an instrument that could conceivably cause some arguments. It is made by Green Bank Scientific Co., Box 100, Green Bank, W. Va., along with several other similar instruments. It's a digital-readout Sobriety Tester. You get a definite PASS or FAIL readout. Figure 21 shows the instrument.

There are probably many other uses for these versatile and highly accurate instruments, but this is a representative sampling of what is being done in the field at the moment. **R-E**

FIG. 16—HIGH-CAPACITANCE METER accurately reads capacitor values as large as one Farad.

FIG. 17—DIGITAL DELAY MODULE by Tektronix. Thumbwheel switch for getting count is also digital readout.

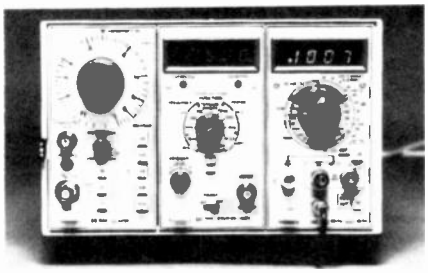


FIG. 18—COUNTER/TIMER module with digital display is part of new Tektronix instrument system.

FIG. 19—SON OF 260 is the Simpson model 360 digital vom.

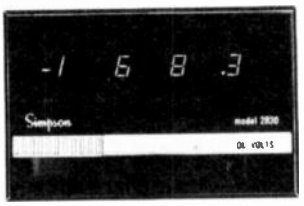


FIG. 20—DIGITAL PANEL METER can be used to read almost any quantity.

FIG. 21—MOST UNUSUAL DIGITAL instrument we found is this Green Bank Scientific Sobriety Tester.

40 PROJECTS Using COSMOS Digital IC's

This is part III in a series of articles describing COSMOS IC's, the latest in solid-state technology. Monostable and astable multivibrator circuits are described here, along with simple circuits you can build.

by R. M. MARSTON

IN PART II OF THIS SERIES WE LOOKED AT the operating principles of COS/MOS digital IC's, and explored a number of practical ways of using the CD4001 IC in inverter, gate, and logic applications. We went on to discuss bistable multivibrator applications.

In this third part of the series, we go on to look at monostable and astable multivibrator applications.

Monostable multivibrator projects

A basic monostable or one-shot multivibrator can be made from two NOT or NOR logic gates by direct-coupling the output of one gate to the input of the other, and by coupling the output of the second gate to the input of the first via a simple R-C time constant network. Figure 21 shows a practical way of making a basic monostable multivibrator, or pulse stretcher, from one half of a CD4001 COS/MOS IC. You can also use the KD4001.

Here, gate A is used as a NOR logic element, and gate B is used as an inverter or NOT gate. The circuit action follows:

Normally, when the circuit is in its quiescent state, the input to gate B is held high via R1, so the output at gate B is low: Both input terminals of gate A are thus low, so the output of gate A is high. Consequently, since both ends of C1 are high, C1 is fully discharged.

Suppose now that a brief positive trigger pulse is applied to the input of gate A. As soon as this pulse is applied, it drives the output of gate A to ground and drags the input of gate B with it via discharged capacitor C1: Consequently, the output of gate B immediately goes high, and thus holds the output of gate A in the low state even when the input trigger pulse is subsequently removed.

As soon as the output of gate A goes low as the result of the applied trigger pulse, C1 starts to charge via R1, and an exponential rising voltage is applied to the input of gate B via the R1-C1 junction. Eventually, after a delay determined by the R1 and C1 values, this exponential voltage rises to the transfer voltage of gate B, and at this point, the output of gate B switches sharply back into the low state. As the output of gate B goes low it

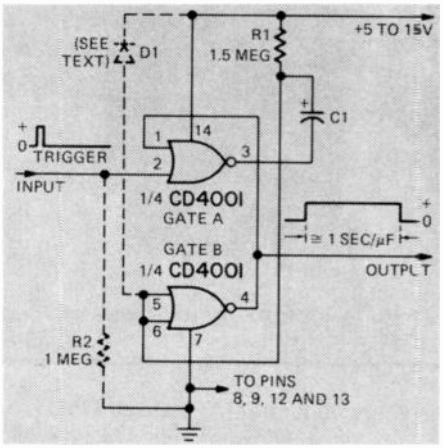


FIG. 21—BASIC MONOSTABLE MULTIVIBRATOR or pulse stretcher.

causes the output of gate A to go high: C1 then discharges rapidly via the output of gate A and input protection diode D1 (see Fig. 7-b, September 1974 issue) of gate B, and the operating sequence is then complete.

Thus, the output of the Fig. 21 circuit is normally low, but goes high as soon as a brief positive trigger pulse is applied to the input: The output then remains high for a certain period, and then switches abruptly back to the low state again: The precise period of the output pulse is determined by the R-C time constant, and by the value of the transfer voltage of the individual CD4001 IC that is used.

Three points should be noted about this particular circuit. The first point is that, since the period of the circuit is dependent on the transfer voltage of the particular CD4001 that is used, the period that is obtained using a particular set of R-C values can vary considerably between one CD4001 and another. The CD4001 in fact has a production transfer voltage spread of 30% to 70% of the supply voltage.

In practice, the transfer voltage of any particular CD4001 is almost constant over a wide range of temperature and supply voltages, so the Fig. 21 circuit has excellent stability, but must have its time constant values individually adjusted to give a particular timing period. The Fig. 21 circuit in fact gives a period of roughly 1 second per μF of C1 value when R1 has a value of 1.5 megohms.

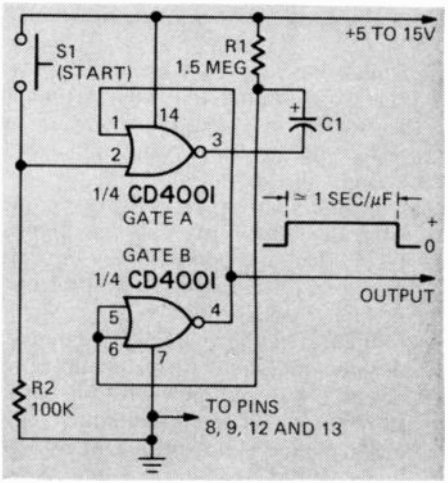


FIG. 22—"NOISELESS" PUSH BUTTON or manually-triggered monostable.

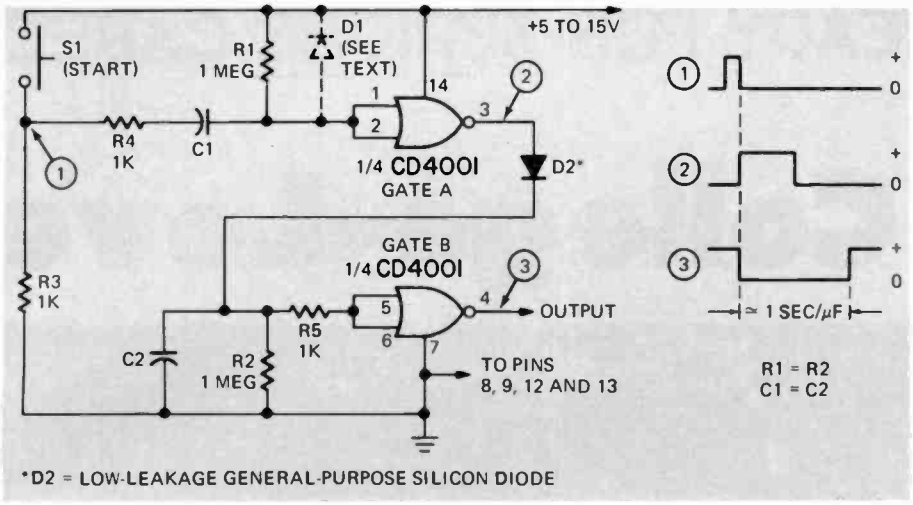


FIG. 23—BASIC COMPENSATED monostable multivibrator.

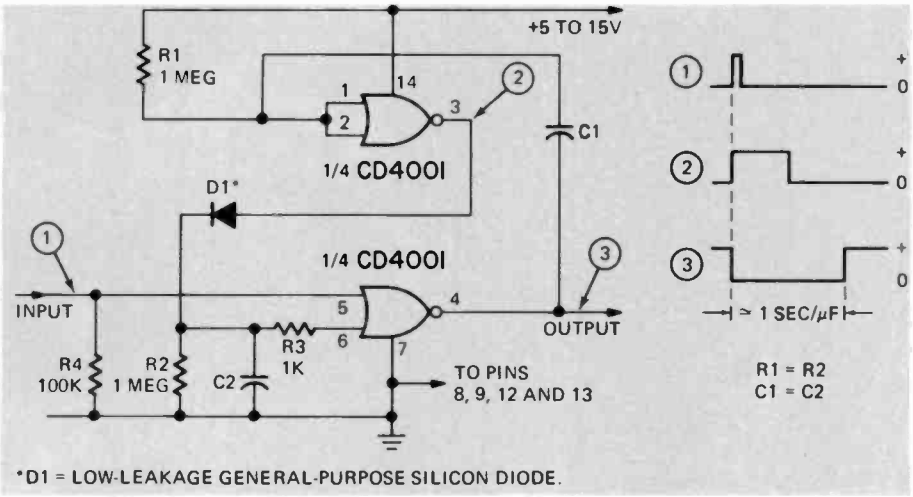


FIG. 24—IMPROVED COMPENSATED monostable multivibrator.

C1 can have any value between a few pF and hundreds of μF: The value of R1 can range from a few thousand ohms to thousands of megohms, if required.

The second point to note about the circuit is that its input must always be tied to ground in the absence of the positive trigger pulse: This requirement can be met by applying the input from a permanently connected dc source, or by strapping the input terminal to ground via a 1-megohm resistor, as shown dotted by R2 in the diagram.

The final point to note is that, since an exponential voltage is applied to the input of one of the gates during the operating cycle, the gate is driven into its linear region during each operating cycle. A measurable current thus flows in the circuit during the operating period. All COS/MOS monostable and astable multivibrator circuits in fact pass a measurable current when they are in their functional modes.

Figure 22 shows how the circuit in Fig. 21 can be used as a 'noiseless' push-button or manually-triggered monostable by simply using the push-button to apply the positive trigger pulse to the circuit.

It has already been pointed out that a snag with the basic monostable circuit of Fig. 21 is that its period depends on the transfer voltage of the individual CD4001, and is not dictated solely by the R and C values. Figure 23 shows the basic circuit of a compensated monostable multivibrator that does not suffer from this snag. The diagram also shows the basic waveforms of the circuit. Note that the circuit uses two sets of R-C time-constant components. Circuit operation is as follows:

When the circuit is in its quiescent state the S1 side of C1 is grounded via R3, but the R1 side is held positive: C1 is thus fully charged under this condition, and the input of gate A is high. The output of gate A is thus low, so C2 is fully discharged at this time, and the output of gate B is high.

Suppose now that START button S1 is briefly closed and then released. As S1 is closed, the S1 end of C1 is connected to the positive supply line, and C1 discharges rapidly via R4 and D1 (which is one of the input protection diodes built into the CD4001): This action has no effect on the circuit. When S1 is released, however, C1 is fully discharged, so as soon as S1 is released, C1 starts to recharge via R1, R3, and R4, thus pulling the input of gate A low and making the output of gate A go high: As the output of gate A goes high, it charges C2 rapidly via D2, and thus causes the output at gate B to go low.

As soon as S1 is released, C1 starts to charge up, and a rising exponential voltage is applied to the input of gate A. After a time determined by the R1 and C1 values, this voltage RISES to the transfer voltage of gate A, and at this point the output of gate A switches sharply into the low state and removes the charging voltage from C2 as D2 becomes reverse biased. C2 then starts to discharge via R2, and after a time determined by the R2 and C2 values, the C2 voltage FALLS to the transfer voltage of gate B, and at this point the output of gate B switches sharply into the high state. The operating sequence of the circuit is then complete. Note that R4 and R5 are used purely as safety resistors, and prevent heavy capacitor discharge currents from flowing into the IC gates if power is removed from the circuit during the operating sequence.

Now, this particular circuit uses two identical R-C time constant networks, and its final output period is equal to the sum of the two individual time constants. The important point to note, however, is that one of these time constants causes a circuit action when its exponential voltage RISES to the transfer voltage of gate A, and the other causes a circuit action when its voltage FALLS to the transfer voltage of gate B. Consequently, if both gates have identical transfer voltages, the transfer voltage values effectively cancel out, and have no effect on the actual period of the circuit.

For example, if both gates have transfer voltages of 30%, C1 will have to charge to 30% of the supply voltage to cause gate A to change state, and C2 will discharge by 70% of the supply voltage to cause gate B to change state, thus giving a total voltage change of 100%. If, on the other hand, both gates have transfer voltages of 40%, C1 will charge to 40% and C2 will discharge by 60% during the operating sequence, again giving a total voltage swing of 100%. The total period of the circuit is thus independent of the transfer voltage value of the IC, providing that both gates have identical transfer voltage values.

Now, although transfer voltage values can vary over wide limits between individual COS/MOS IC's, the individual transfer voltage values of a set of gates within a single CD4001 are always virtually identical, since the gates are all formed on the same semiconductor chip at the same time. Consequently, the total timing period of the Fig. 23 circuit is dictated purely by the values of R1-C1 and R2-C2, and is independent of variations in the parameters of individual CD4001 IC's.

The Fig. 23 circuit is shown as being manually triggered. The circuit can be modified for electronic triggering by simply eliminating S1 and applying the positive trigger pulse across R3. In either case, a practical disadvantage of the circuit in Fig. 23 is that the actual monostable action is initiated by the end, rather than the start, of the input trigger pulse. This snag can be overcome by modifying the circuit as shown in Fig. 24.

This circuit gives an output that is normally high (positive), but which goes low (to zero volts) for a preset period when a trigger pulse is applied. If re-

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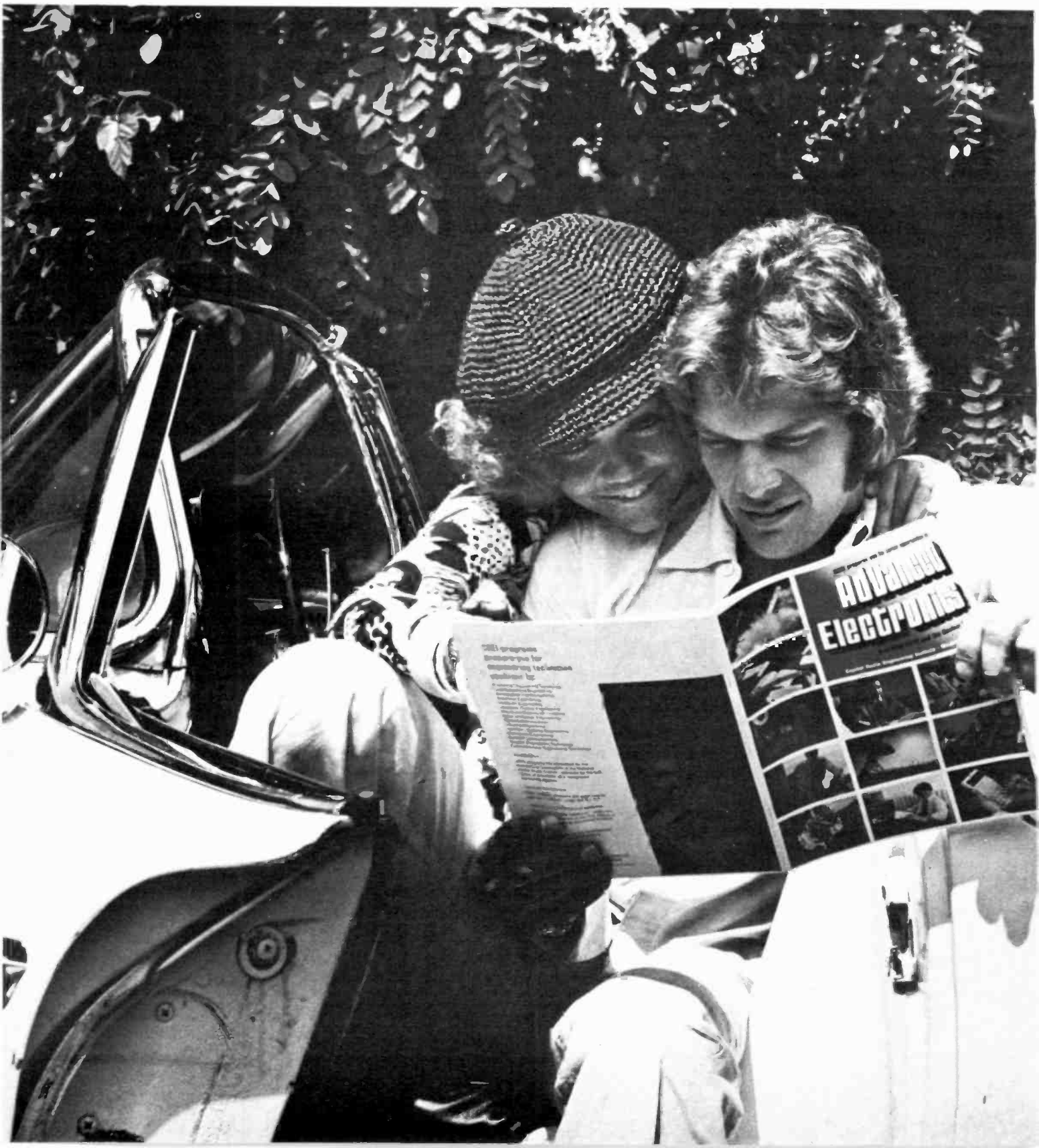

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quired, the polarity of the output signal can be reversed, so that it is normally low but goes high for the duration of the output pulse, by simply wiring an inverter into the output of the circuit in Fig. 24, as shown in the positive-output compensated monostable circuit of Fig. 25.

Astable multivibrator circuits

The most widely used type of multivibrator circuit is the astable, or square-wave generator. Figure 26 shows how one half of a CD4001 COS/MOS IC can be used to make a basic 1-kHz astable multivibrator. Note that both gates of the circuit are connected as simple inverters, and that the circuit uses only a single set of R-C time constant components. The action of the circuit is as follows:

Suppose initially that a stage has been reached in the circuit operation where the output of gate B has just switched into the high state and the output of gate A has just switched into the low state, and that C1 is fully discharged at this moment.

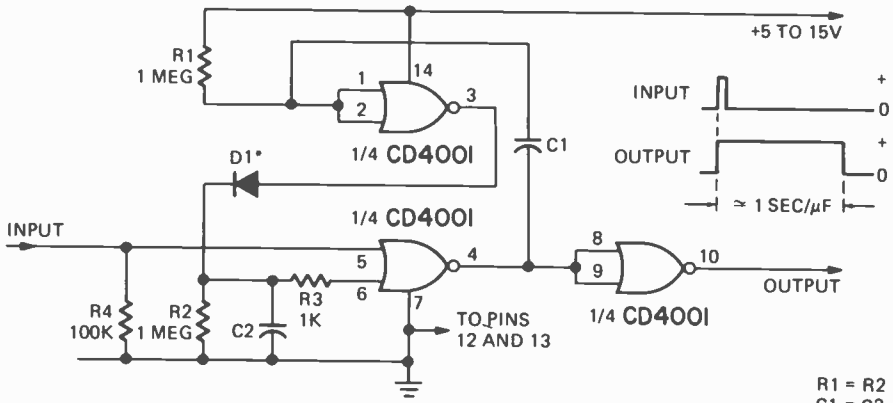
Since C1 is discharged at this time, the input of gate A is effectively shorted to the output of gate B, and is high. As soon as the above stage of operation is obtained, C1 starts to charge up via R1 and the low (effectively grounded) output of gate A (which is derived from the R1-C1 junction) starts to decay exponentially towards zero.

Eventually, after a delay determined by R1 and C1, the input voltage of gate A falls to the transfer voltage point of gate A and at this instant, the output of gate A switches into the high state and drives the output of gate B into the low state: As the output of gate B switches to the low state, it forces the positive end of C1 downwards, and thus forces the gate A input end of C1 to attempt to swing negative with respect to the zero volts line: As the input of gate A goes negative to the zero volts line, input protection diode D3 (see Fig. 7-b, September 1974 issue) conducts and removes the charge from C1.

Thus, at the end of this switching cycle, C1 is again fully discharged, the output of gate B and the input of gate A are low, and the output of gate A and the input of gate B are high.

As soon as this new stage of the operation is obtained, C1 starts to recharge in in the reverse direction via R1 and the low (grounded) output of gate B, and the voltage at the input of gate A (which is derived from the R1-C1 junction) starts to rise exponentially towards the positive voltage. Eventually, after another delay determined by R1 and C1, the input voltage of gate A rises to the transfer voltage of the gate and at this instant, the output of gate A switches into the low state and drives the output of gate B into the high state.

At this moment, C1 discharges rapidly via input protection diode D1 of gate A as the R1-C1 junction end of the capacitor attempts to go positive relative to the positive supply line, and the operating sequence is then complete. The switching sequence then repeats ad infinitum, and a series of approximately



*D1 = LOW-LEAKAGE GENERAL PURPOSE SILICON DIODE

FIG. 25—POSITIVE-OUTPUT compensated monostable multivibrator.

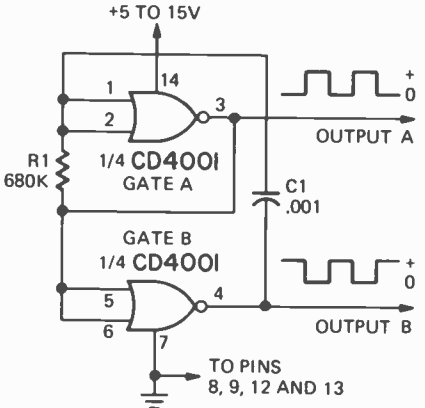


FIG. 26—BASIC 1-KHZ ASTABLE multivibrator or square-wave generator.

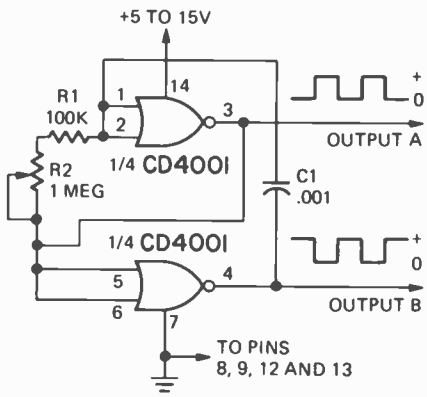


FIG. 27—VARIABLE FREQUENCY (600 Hz-6 kHz) astable multivibrator.

square waves are generated at the two outputs of the circuit: Outputs A and B are 180° out of phase.

An outstanding feature of the basic astable multivibrator circuit of Fig. 26 is that it uses only two time constant components (R1 and C1), and the values of both of these components can be varied over wide ranges to give required operating frequencies. The value of R1 can be varied from a few thousand ohms to thousands of megohms, and C1 (which must be a non-polarized capacitor) can be varied from a few pF to several μF. The operating frequency is inversely proportional to the R1 and C1 values, and can be varied from less than one cycle per hour to several MHz.

The operating frequency of this circuit can be made variable, if required, by

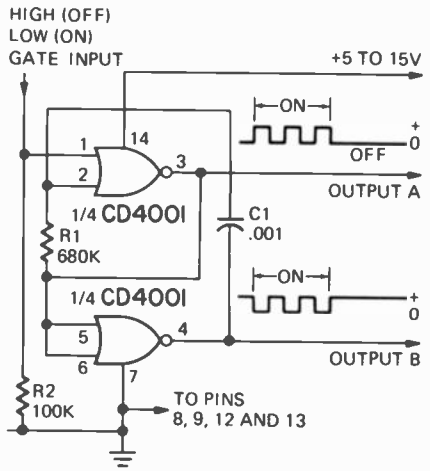


FIG. 28—GATED 1-KHZ ASTABLE multivibrator.

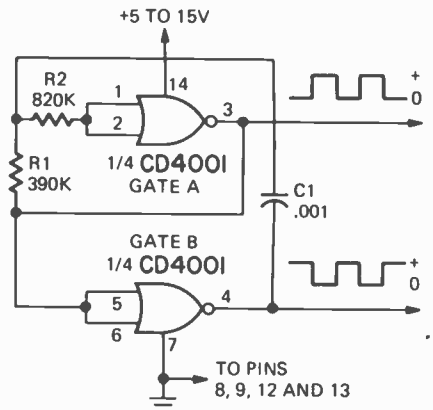


FIG. 29—COMPENSATED 1-KHZ astable multivibrator.

wiring a variable resistor in series with limiting resistor R1, as shown in the circuit of Fig. 27. With the component values shown, this circuit covers the approximate frequency range 600 Hz to 6 kHz.

If required, the basic astable multivibrator of Fig. 26 can be gated on or off via an external pulse signal by connecting gate A as a NOR gate and applying the gating signal to one of the NOR gate inputs, as shown in Fig. 28. The multivibrator is cut off when the gate input signal is high, and is operative when the gate input signal is low.

The basic astable multivibrator of Fig. 26 acts as a simple and very useful circuit, but suffers from several disadvantages. The first of these is that, since the

(continued on page 88)

new FTC ratings for audio amplifier power

are they any good?

There are some potential loopholes in the newly imposed FTC rules. Here's a look at how they work and where the problems may lie

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

BY THE TIME YOU READ THIS, MANY manufacturers of home entertainment audio products will be busily printing new advertising literature, specification sheets and even the outside of packing cartons. No, the industry has not suddenly redesigned its entire product line—the amplifiers haven't changed that much. But they are changing the statements regarding their power output capability to bring them into line with a new trade regulation promulgated on May 3, 1974 by the Federal Trade Commission. The new rule becomes effective November 4, 1974 and the FTC will consider violations after that date to be "an unfair method of competition and an unfair or deceptive act or practice within the meaning of Section 5 (a) (1) of the Federal Trade Commission Act 15 U.S.C. S 45 (a) (1) to violate any applicable provision of this rule."

Reasons for the FTC action

Over the past few years, some segments of the audio industry have been engaged in a quasi-technical semantic race to devise power output statements for audio amplifiers which would yield higher and higher numbers of "watts of output" for their products. About the only thing these assorted specifications had in common was their use of the word "watts" as a measure of power. But what "kind" of watts were used? There were "continuous watts" —the amount of power that an amplifier would deliver on a continuous basis into a fixed, resistive load.

This measurement, the most conservative of all, became known as rms power, a term which in itself is semantically meaningless. The letters rms stand for "root-mean-square." Many ac voltmeters are calibrated to read 0.707 of peak sinusoidal ac voltage applied to their terminals. In the case of a *sine wave*, power developed across a load is defined by the Formula $(E_{rms})^2/R = P$, where E_{rms} is the root-mean-square voltage, R is the resistive component of the load impedance across which the output voltage is applied and P is the resulting power in watts. Power itself cannot be termed rms because musical waveforms are seldom, if ever sinusoidal and as an amplifier is driven into clipping or overload, even a pure sinusoidal waveform changes shape so that voltmeter readings no longer correspond to 0.707 of peak voltage values. Nevertheless, the term "rms power" persists and for our purposes can be considered identical to "continuous power"—the more appropriate term.

Another term "music power" (also known as "dynamic power, IHF Dynamic Power or IHF Music Power") has been used to describe amplifier power output at somewhat higher numerical values of wattage. The numbers are based upon the fact that for short periods of time, most amplifiers can deliver somewhat more power than they can on a continuous basis. Since musical waveforms contain relatively short bursts of higher energy, many experts felt that "music power" represented a more meaningful way to describe an amplifier's power output capability.

Unfortunately, "music power" quickly became corrupted and gave way to such meaningless terms as "peak power," "peak music power," instantaneous peak power (IPP) and even "instantaneous peak music power." Each of these successive manipulations of terms gave rise to higher and higher wattage figures. It was not uncommon to find products rated at 100 watts "IPP" which actually produced 5 watts or less of "continuous power." Small wonder that the FTC stepped in and tried to bring some order into these chaotic audio specs.

A summary of the FTC rule

To begin with, the new FTC regulation requires that all audio products that deliver more than a 2-watt output must specify, in boldest advertising type, the following with regard to power output:

1. "The minimum sine-wave continuous average power output, in watts, per channel —
   a. for **each** load impedance for which the equipment was designed
   b. measured with **all** channels driven
2. The manufacturers rated power band or power frequency response, in Hertz (Hz) for each of the rated power outputs required to be disclosed per item (1) and
3. The manufacturer's rated percentage of maximum total har-

monic distortion at any power level from 250 mW to the rated power output for each rated power output and its corresponding rated power band or frequency response.

A "Legal" power statement

Based upon our interpretation of the above, the following might constitute a proper power output disclosure:

"Brand "X" amplifier has a rated power output of 50 watts per channel, all channels driven, into an impedance of 8 ohms, at any frequency from 20 Hz to 20 kHz, with harmonic distortion not exceeding 0.5%." Similar statements would also have to be made with appropriate numbers substituted for 4 ohm and 16-ohm loads, if the amplifier were designed to operate into these additional load impedances.

Remaining ambiguities

To paraphrase astronaut Armstrong, the new FTC rule represents "one giant step" for the audio industry—but the typical hi-fi component purchaser can still be subjected to ambiguities and confusion even if the new rules are strictly followed and enforced. Consider, first, the two power output curves of Fig. 1. Both amplifiers "A" and "B" could be described exactly as in the example

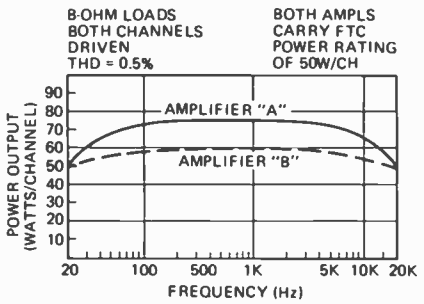


FIG. 1—POWER VERSUS FREQUENCY of two amplifiers at 0.5% THD rating.

above. Each can produce 50 watts at 0.5% THD at the frequency extremes of 20 Hz and 20 kHz. Note, however, that if the power bandwidth had been limited to from 50 Hz to 10 kHz, amplifier "A" could have well been rated as a *70-watt-per-channel amplifier* and, with that limitation, would "read" as the better amplifier (which in fact, it actually is).

Figure 2 presents a more confusing situation. The manufacturer of amplifier "B" now *chooses* to rate his amplifier as a 100-watt unit—but at a power bandwidth extending only from 100 Hz to 5 kHz. While more conservative manufacturer "A" prefers to provide data on bandwidth from 20

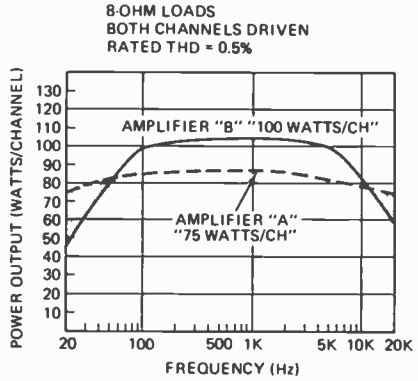


FIG. 2—"LOWER POWERED" AMPLIFIER A can actually produce more power at frequencies in shaded areas because of its better power bandwidth.

Hz to 20 kHz, and therefore limits his power rating to 75 watts. Amplifier "A" will probably sound better when pushed to its power limit, because the low frequency energy demands of music are great, and at 40 Hz, amplifier "A" is actually capable of audibly greater power output than amplifier "B". If this idea is carried to its ridiculous extreme, there is nothing to prevent an amplifier manufacturer from specifying power bandwidth from 999 Hz to 1001 Hz so as to come up with the highest wattage rating possible (power output at mid-frequencies is almost always easier to achieve than at frequency extremes. Only an educated consumer could be expected to understand this subtle subterfuge and separate the good amplifier from the not-so-good one.

Thus far, we have given examples of pairs of amplifiers having identical rated harmonic distortion (THD). In this area, too, there is unlimited latitude for manufacturers to take. Consider Fig. 3. Amplifier "B" appears to have greater power output than amplifier "A" and even has great power bandwidth (20 Hz to 20 kHz against 30 Hz to 20 kHz) but is it, indeed the "better" amplifier? Its rated distortion is quoted as 1.0% while that of amplifier "A" is quoted as 0.1%. If amplifier "A" were driven harder, so as to produce the 50 watts shown for amplifier "B," would its distortion be

	AMPL A	AMPL B
POWER OUTPUT	40	50
RATED THD	0.1%	1.0%
POWER BANDWIDTH	30Hz–20 kHz	20Hz–20 kHz

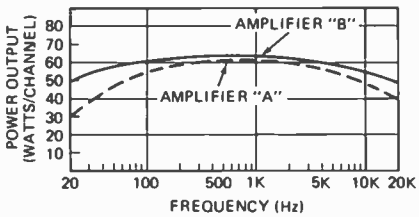


FIG. 3—SINCE MANUFACTURERS MAY QUOTE different rated harmonic distortions for their products, a fair comparison of these two amplifiers cannot be made without further information or lab testing.

better, equal to, or worse than the 1% quoted for amplifier "A"? Further, would its power bandwidth then equal or exceed the 20 Hz to 20-kHz bandwidth quoted for amplifier "A"? The only way a consumer can know would be to take both amplifiers to a properly equipped laboratory and have them measured under identical conditions, even though *both* manufacturers have fully complied with the new FTC rule.

Pre-conditioning tests

In an attempt to insure that all amplifier ratings are determined on the basis of long term operation and stability of the product being specified, the FTC rule also calls for certain standard test conditions (120-volt supply voltage for example) and a one hour pre-conditioning test during which the amplifier is required to deliver ⅓ of its rated power to a resistive load. Anyone familiar with class "B" operation of solid state amplifiers knows that maximum internal power dissipation of the output transistors occurs when 40% of maximum power is delivered to the external loads. Since ⅓ of full power is very close to 40% of full power, this means that the output devices will be dissipating nearly their maximum. Many better amplifiers are equipped with electronic protection circuits which would interrupt power under these conditions. In theory, such amplifiers would have fulfilled their pre-conditioning tests even if no power were delivered to the loads for the last 40 minutes of the specified hour—though surely the avowed *purpose* of the pre-conditioning would not have been fulfilled.

On the other hand, manufacturers of less sophisticated amplifiers (which might well destroy themselves or blow their output fuses during these pre-conditioning tests) may well have to derate their stated power output figures or add cost to their products in the form of larger heat sinks or over rated power output semiconductors. This strikes us as unfair to the consumer and the manufacturer. It is well known that under musical playback conditions, average power output from an amplifier (over a long time period) can be expected to be about 10-dB lower than maximum power produced during moments of loud musical crescendos. Thus, a pre-conditioning test at 10% of rated power would have been more realistic and more meaningful. Such a 10% pre-conditioning test was, in fact, called for in the now obsolete IHF measurement standards.

Other power disclosures

The FTC rule does not specifically prohibit the publication of power out-

put ratings other than the preferred "continuous" power. It does, however, require that such optional disclosures as "peak power" or "music power" be accompanied by a disclosure of the other accompanying parameters such as impedance and power bandwidth. Distortion, however, need only be quoted for the additionally disclosed rated output (and not all the way down to 250 mW, as in the case of continuous power). The FTC further requires that such optional disclosures be less conspicuously or prominently made than the continuous power output disclosure. They go on to define "less conspicuous" as not being in bold face type nor in type which is more than two-thirds the height of the continuous power disclosure. The advice to the audiophile would seem to be "Read the large print and ignore the fine print!"

A Noble Beginning

Our criticism of the newly issued FTC power rule should not be taken as a negative one in all respects. Certainly the need existed for some clarification of this primary specification as it applies to home audio equipment. We do, however, take issue with those who maintain that the new rule in and of itself, will solve all the problems of misinformation which have been rampant in the audio industry for many years. Literature and advertising matter printed by low-end audio producers of consoles, compacts and low fidelity components will, no doubt, have to be dumped in trash cans (hopefully for paper recycling) and no doubt these hi-fi opportunists will henceforth omit all references to power output rather than be caught with their one or two watts showing.

Reputable manufacturers of good quality component equipment will hardly be affected by the new rule, since they have generally gone beyond its disclosure requirements in the past.

The real point to be made is that the potential audio consumer not be lulled into a false sense of security when reading post-November 1974 specification sheets. There can still be confusion—and you are still not assured of being able to compare products on a totally equal basis. Hopefully, the Institute of High Fidelity will come up with new Amplifier Measurement Standards which should help to make power amplifier specifications more uniform. Until that happens, it's up to the consumer to read specs carefully, compare performance through listening tests, and rely on the hard earned reputation of legitimate high fidelity component manufacturers. **R-E**

equipment report

Hewlett-Packard 1221A and 1220A Oscilloscopes

THE HEWLETT-PACKARD CO., MAKERS of precision instruments have come up with a new solid-state triggered-sweep oscilloscope that should be ideal for most kinds of electronic work. There are two models; the 1221A single-channel, and 1220A dual-trace. Otherwise, the two are identical.

The vertical amplifiers have a very wide response, from dc up to 15 mHz, at a risetime of 23 ns. The dual-trace displays in the 1220A use two different modes. The signals are "chopped" at the lower frequencies, from 0.5 s/div up to 1.0 ms/div. This causes the sweep to display small sections of each waveform alternately. While the beam is traveling from one channel to the other, it is completely blanked. So the two waveforms appear to be continuous.

For the higher frequencies, from 0.5 ms/div up to 0.1 ns/div, the switching goes into an "alternate" mode. Now, each trace is fully scanned, and the beam then switches to the other for a full trace.

Each vertical amplifier is identical. They have calibrated vertical attenuators which cover a range from 2 mv/div up to 10 V/div in 12 separate ranges. A variable attenuator can be used for vernier settings if needed. Pushbutton selector switches allow a choice of CHANNEL A, CHANNEL B, or both at once. The displays are both locked by the signal in CHANNEL A for triggering. Since most work involves signals at the same frequency, one trigger signal can be used for both.

The triggering circuitry will lock in on any signal from 2 Hz to 15 MHz, provided the input signal is large enough to produce one division of vertical deflection. The trigger action is very stable and easily adjusted. Internal, external, or ac line sync can be used by pushing the proper button. For TV work, the 1220A has an internal TV sync separator. This helps to lock any standard TV waveform of either vertical or horizontal frequency.

A slope control allows triggering on either the positive going or negative going portions of the waveform. Incidentally, the TV sync separator can be used as a low-pass filter for other waveform tests, if needed. Another pushbutton control allows the use of a fixed attenuator with the external trigger signal or external sweep. It has two positions 1:10 or 1:1.

For use with an external horizontal sweep signal, the 1220A can be switched to EXT. HOR. input, when the X-Y/ SWEEP switch is pushed. In the X-Y position, the internal horizontal sweep is disabled, and a sweep signal must be fed into the EXT. HOR. Jack. This is for use with sweep alignment equipment. For vectorscope use, the signal from the red grid can go to the CHANNEL A input, and from the blue grid to the EXT.HOR. input

The CRT used in the 1220A is a special type. It has the graticule on the inside of the screen, to eliminate parallax errors. The phosphor used is a special P31 type. The trace is blue, and very bright thanks to the 2 kV accelerating voltage used.

A BEAM-FINDER pushbutton is used if there is no trace on the screen. This partially collapses the sweep, showing you where the pattern is. In addition to this, the triggering circuitry has another very handy feature. Instead of blanking the trace completely if there is no input signal, an automatic circuit causes the trace to appear. This is called the BRIGHT-LINE display. When a signal is applied to the input, the bright-line circuitry is automatically disabled and the triggered sweep operates normally.

Despite all of its complex circuitry the 1220A is a very compact instrument. Only 17 cm high, 30.4 cm. wide and 39.7 cm deep (7 x 12 x 16, in inches). The controls are very clearly marked, and the panel is divided into sections so that confusion is eliminated.

The customary, highly detailed and well-written instruction book and service manual is provided. This gives you full instructions for setting up and operating the 1220A. In addition to this, a very detailed section on the theory and operation of the instrument is included. **R-E**

Step-by-step TV Troubleshooters Guide

Analyzing output waveforms is an integral part of troubleshooting a television receiver. This method pinpoints the defective circuit quickly. Here's a guide to this effective method.

by STAN PRENTISS

WITH THE INTRODUCTION OF BOTH better instruments and solid-state color TV receivers, TV waveform analysis has become a science rather than an art. And several manufacturers are already indicating this as they offer factory-generated keyed rainbow signals for checking overall receiver operation and troubleshooting.

In hybrid and tube sets, marginal operation is still possible and even probable if a component is malfunctioning, but solid state receivers either play or shut down sectionally or completely if a single transistor or IC isn't doing its job. The reason is that semiconductors normally operate at 90% of maximum until they either open or short. Leakage (at least for silicon types) is usually negligible unless man made or caused by poor case seals. So, with RCA announcing no more tube receivers, and other set manufacturers probably following, the days of wholesale component substitutions are past, and an analytical approach to repair must prevail. Better color bar generators will help make this possible.

The general approach

When examining an ordinary block diagram of a color TV receiver, it is important to look at the set in terms of functional units rather than limited stages (see Fig. 1). Using this approach, the overall area of trouble can be located accurately and quickly, then conventional methods such as examining individual parts can take over. With modular and IC receivers this approach should work, for in some of these sets selective waveforms will be either difficult or virtually impossible to obtain. You should, however, be very aware of what each waveform means and why it is there.

Video i.f. amplifiers and agc

As shown in Fig. 2, the upper display (Y1W1) is the total composite video signal. This signal is composed of the vertical sync tips (a); blanking pedestal (b); black peak (c); video information and white peak (d). Point d also shows you when the composite video signal is at full modulation so the agc may be properly set to avoid sync compression. The rf agc is adjusted visually (or with a voltmeter) on weaker signals so that it will become active at some pre-determined dc level (or i.f. agc's strongest output). It's better of course, to use a broadcast signal to set the agc than one from a signal generator since there is usually more than one station in each community, and their signal strengths will normally vary. Using the composite video signal is also an excellent way to determine if agc will drive i.f. amplifiers between cutoff and saturation; such action is normal in well-designed sets. In addition, if the i.f. amplifiers aren't operating correctly; sync, luminance, and chroma are all directly affected, as well as sound. So when servicing a color receiver, check its general video response following the video detector; often your problems begin here and not where they seem to be. Figure 2 also shows the conventional sync pulse tip (Y2W1) with the video removed and a swing of 30 volts p-p. The waveforms in Fig. 2 consist of slightly more than one field since each field is 16.664 μs in duration, and the scope time base is set for a total of 20 μs (10 div. × 2 μs/div.).

Sync pulses

In Fig. 3, all voltages, time base, and dc references for both waveforms

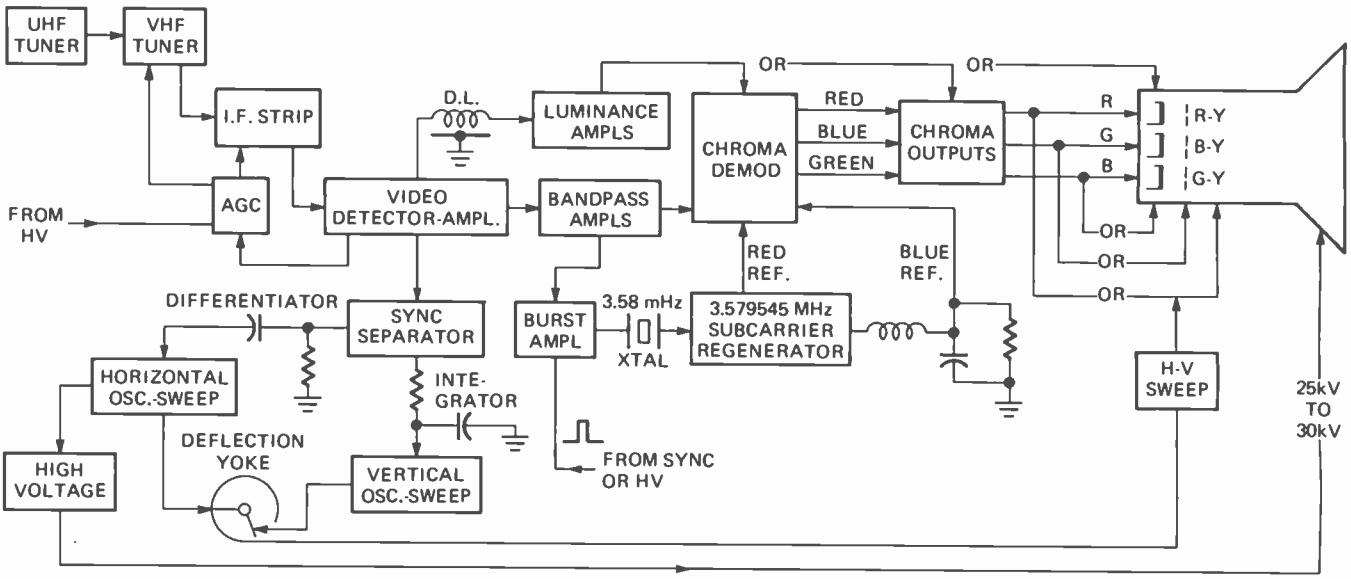


FIG. 1—BLOCK DIAGRAM OF TYPICAL COLOR TV is the same for tube, transistor or IC circuits.

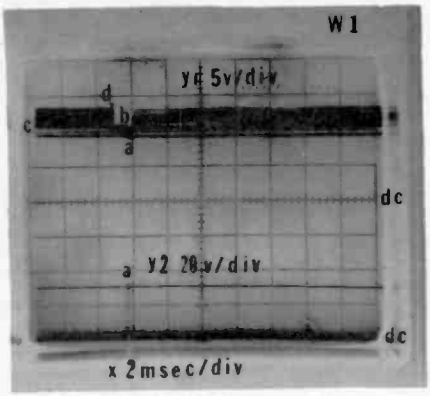


FIG. 2—COMPOSITE VIDEO and sync waveforms.

see, sync is transmitted only when there is no incoming video, so blanking intervals are important too.

The composite video signal is shown again in Fig. 4 (Y1W3) at a sweep rate of 10 μs/div. The composite video signal has a blanking interval (g) of just under 12 μs, and a horizontal sync pulse (h) width of 5 μs. Note that the sync pulse (h) (Y2W3) has a sharp leading edge because of the instantaneous charge of the differentiator and coupling capacitor, but the capacitor discharge forms a sloppy trailing edge. Only the leading edge, however, is used for the receiver's afc

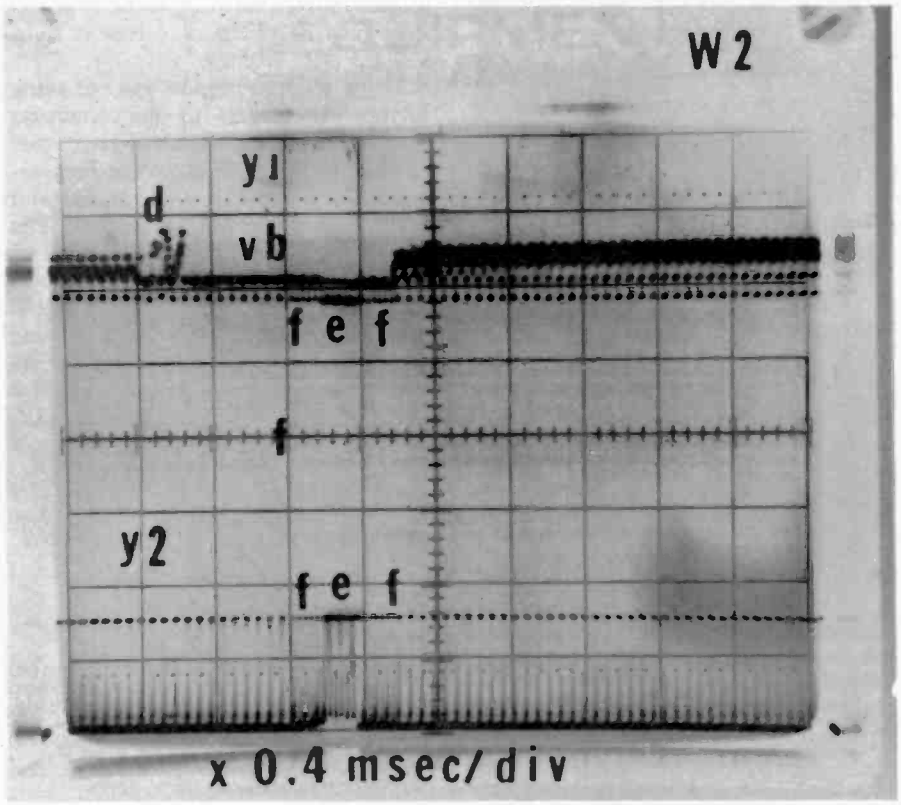


FIG. 3—USING THE SCOPE'S X5 EXPANDER shows the intricate details of Fig. 2.

are the same as in Fig. 2, except we're using the oscilloscope's X5 expander that produces a sweep of 0.4-ms per division instead of 2 ms/div. The blanking interval and sync pulse details now become quite distinct. The 1.4 ms vertical blanking (two fields to a frame) can now be measured quite accurately, and the six vertical pulses (e) are very evident in both waveforms as are the six equalizing pulses (f) which precede and succeed them. If this sync information had been compressed or distorted, the deflection circuits would be malfunctioning, especially the vertical oscillator which is often affected first. Although you won't be expected to count these vertical sync and equalizing pulses each time there is a sync problem, it is comforting to know they're there and not buried somewhere they shouldn't be. As you can

sync time comparison. So there's no confusion between leading and trailing edges, let's reverse polarity of the sweep, and show the trace from left to right in Fig. 5, rather than vice versa. What's important about the waveshapes in Fig. 4 is that both sync pulses (Y1W3, Y2W3) should have enough amplitude, duration, and be of the proper shape, for without all these your sync problems can be severe.

Color bar generator substitution

There is only a slight difference in the waveform's video content as we substitute a color bar signal, but the horizontal sync pulse remains the same, as Fig. 5 shows. The pulses in place of video in Y1W4 are the 11 color bars. Bar No. 12 has already been used by the generator as a sync pulse, and No. 11 will be removed by the receiver's blanking circuit before it reaches the chroma demodulator. In the chroma-luminance output, therefore, you'll only see 10 color bars, which represent keying of the color bar oscillator at 30° intervals, producing a rainbow sweep from burst to 300°, inclusive.

The vertical output pulses for all receivers are somewhat similar, but there are horizontal drive differences between tube and solid state receivers. In the tube receiver, the horizontal output signal shown in Fig. 6 (Y1W5), measures 250 volts p-p while the vertical output (Y2W5) is almost 1000

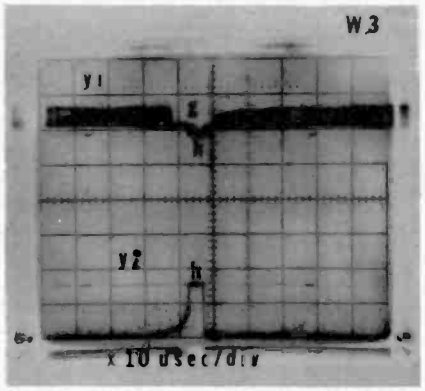


FIG. 4—A FAST SWEEP RATE IS USED to show the blanking interval and sync pulse.

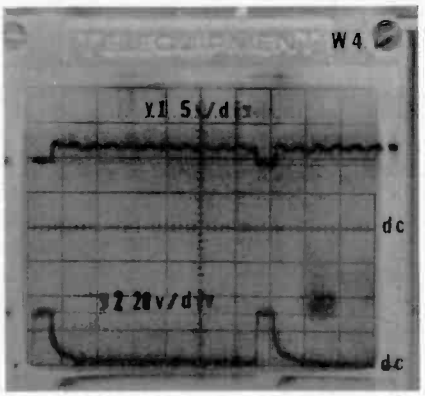


FIG. 5—INTRODUCING THE COLOR BAR GENERATOR.

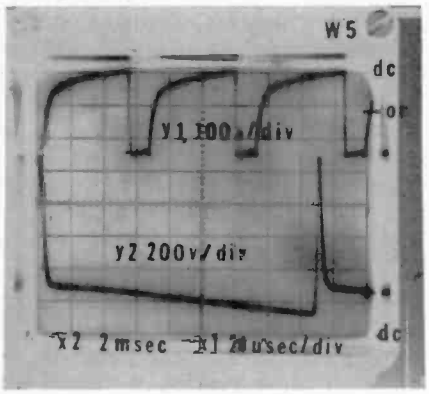


FIG. 6—HORIZONTAL DRIVE and vertical output signals of a tube color set.

volts p-p. In addition, although the vertical waveform is universal for all sets, the tube horizontal drive pulse must be semi-trapezoid (pulse and

sawtooth combined) to drive both inductance and resistance in the yoke and flyback circuits, while solid-state versions interface at much lower impedances and may use rectangular waves with duty cycles of approximately 50%. Whether trapezoidal or rectangular, neither waveform drives the horizontal output for more than half the total cycle, so that the output is on for only half the waveform, and only reaches dc and cutoff at its very peak.

In RCA's SCR horizontal deflection drive circuit it's worthwhile looking at all three drive and output traces (Fig. 7). Here we're dealing with silicon controlled rectifiers, and when they conduct, the output voltage drops towards dc. And when they're cut-off the output voltage rises. Therefore, the horizontal oscillator trigger (trig, W6) sends the retrace (comm. W6) into conduction and it remains in that state for 25 μs. During that interval, the trace SCR cuts off and stops conducting for about 10 μs. The scope trace then shows that the commutator SCR does not conduct for some 38 μs, making a total horizontal sweep time of 63.5 μs. The trace SCR (and diode) conducts for a total of some 53 μs.

Chroma circuits

Chroma circuits are no more difficult to analyse than luminance and sync circuits, but you may not be used to the clean test patterns on some of the better sets. In these circuits the bandpass amplifiers, burst, 3.579545 mHz subcarrier oscillator, and the chroma-demodulated output are all needed to complete the analysis. So with the preset composite video signal following the video detector, the task shouldn't be that difficult. Deviations at this point, however, means there are specific problems in the receiver and they should be attended to before continuing.

Chroma and demodulator outputs should be examined first, if there is no color but good black and white. In most integrated circuit receivers, luminance information is added either in the demodulator chip itself (Fig. 1), or directly into the chroma output amplifiers. The reasoning here is to combine luminance information and chroma (color) information before the picture tube so both signals can have identical impedances, proper ac and dc levels, and be routed to the picture tube through one set of electrodes. However, you may not see the red and blue amplifier outputs displayed as cleanly as those in Fig. 8 (R-YW6 and B-YW6) unless the luminance signal is shunted to ground with about an 80 pF capacitor.

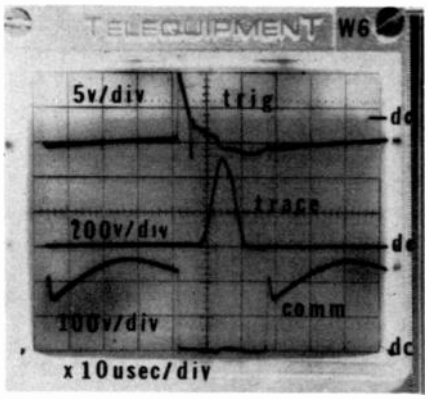


FIG. 7—RCA's SCR deflection waveforms.

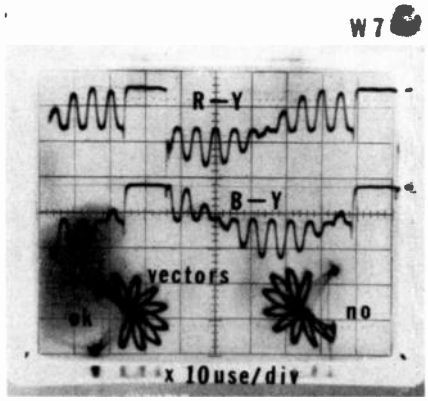


FIG. 8—R-Y AND B-Y OUTPUT and vector patterns.

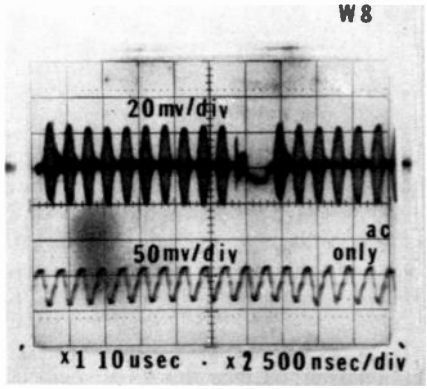


FIG. 9—CHROMA IC AMPLIFIER OUTPUT and subcarrier sinewave.

Obviously, if you have such waveforms with the red zero reference voltage at bar six, and the blue zero reference voltages at bars three and nine; and plenty of amplitude, your chroma sections are operating well. The two 11-μS rectangular pulses cut off the pix tube during line retrace. Further confirmation of the chroma section comes from the two vector patterns in Fig. 8 (W6) although the right one is upside down and the scope's horizontal and vertical polarities must be reversed to turn it right side up (left vector).

If the chroma outputs are not satisfactory, backtrack to the bandpass amplifier and see if it has an output at least in the millivolt range in semiconductor sets, (Fig. 9, top trace) and in the volt range in hybrid sets. The bottom trace of Fig. 9 is the output of the 3.58-MHz oscillator viewed at 500 μS/div. If either the color information or the subcarrier reference is missing or is off frequency, then there is no demodulation and no color. **R-E**

NEW ELECTRICAL CODE ADOPTED

The National Fire Protection Association adopted the revised and corrected 1975 National Electrical Code as its standard at its meeting in Miami last Spring. The new code's publishing date is September, replacing the present 1971 edition.

The new edition contains some significant changes, relaxing provisions of the old Code in some places and tightening them in others. Thus Section 336-3 (Nonmetallic Sheathed Cable) now permits types NM and NMC cable to be used in certain types of dwelling and other structures, and Sections 230-208 and 240-100 (Services and Overcurrent Protection) deletes requirements pertaining to visual current indication. But Section 300-15b (Wiring Methods) limits the use of certain devices without separate boxes. In several sections, some requirements that had been applied only where voltages were over 600 are now general requirements.

R-E's Substitution guide for replacement transistors

PART XXI

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., 101 S. Parker, Indianapolis, Ind. 46201

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

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

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

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

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

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

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	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N4348	NA	T-707	NA	ICC-707	IRTR-61	PTC 118	HEP-707	SK 3079	NA	NA	WEP-707	ZEN 204
2N4349	NA	TS-3020	GE-28	ICC-S3020	NA	PTC 144	HEP-S3020	NA	NA	NA	WEP-S3020	NA
2N4350	NA	TS-3001	GE-28	ICC-S3001	NA	NA	HEP-S3001	NA	NA	NA	NA	NA
2N4352	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N4354	RS276-2021	T-708	GE-67	ICC-708	TR-19	PTC 127	HEP-708	SK 3025	RT-115	ECG 159	WEP-717	NA
2N4355	RS276-2021	T-708	GE-67	ICC-708	NA	PTC 127	HEP-708	SK 3114	RT-115	EGC 159	WEP-717	NA
2N4356	RS276-2021	T-708	GE-21	ICC-708	NA	PTC 103	HEP-708	SK 3114	RT-115	ECG 159	WEP-717	NA
2N4359	NA	TS-0006	GE-67	ICC-S0006	NA	PTC 127	HEP-S0006	NA	NA	NA	WEP-717	NA
2N4360	NA	TF-1035	NA	ICC-F1035	NA	NA	HEP-F1035	NA	NA	NA	NA	NA
2N4381	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N4382	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N4383	NA	TS-3026	NA	ICC-S3026	NA	NA	HEP-S3026	NA	NA	NA	WEP-3023	NA
2N4385	NA	TS-3026	GE-63	ICC-S3026	NA	NA	HEP-S3026	NA	NA	NA	WEP-3023	NA
2N4386	NA	NA	GE-63	NA	NA	PTC 136	NA	NA	NA	NA	WEP-3020	NA
2N4387	RS276-2025	T-702	GE-69	ICC-702	IRTR-58	PTC 113	HEP-702	SK 3083	RT-133	ECG 153	WEP-700	NA
2N4388	RS276-2025	T-702	GE-69	ICC-702	IRTR-58	PTC 113	HEP-702	SK 3083	RT-133	ECG 153	WEP-700	NA
2N4389	NA	T-57	NA	ICC-57	IRTR-54	PTC 103	HEP-57	SK 3118	RT-126	ECG 106	WEP-52	NA
2N4390	NA	T-713	GE-27	ICC-713	IRTR-87	PTC 117	HEP-713	NA	NA	NA	WEP-53	NA
2N4395	NA	T-247	GE-19	ICC-247	IRTR-59	PTC 119	HEP-247	SK 3027	RT-131	ECG 130	WEP-247	NA
2N4296	NA	T-247	GE-19	ICC-247	IRTR-59	PTC 119	HEP-247	SK 3027	RT-131	ECG 130	WEP-247	NA
2N4399	NA	TS-7001	NA	ICC-S001	TR-20	NA	HEP-S7001	NA	RT-148	ECG 180	WEP-WS7001	NA
2N4400	RS276-2009	T-736	GE-20	ICC-736	TR-21	PTC 123	HEP-736	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 120
2N4401	RS276-2009	T-736	GE-20	ICC-736	TR-21	PTC 136	HEP-736	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 120
2N4402	RS276-2021	T-716	GE-21	ICC-716	IRTR-54	PTC 103	HEP-716	SK 3114	RT-115	ECG 159	WEP-717	ZEN 107
2N4403	RS276-2021	T-716	GE-21	ICC-716	IRTR-54	PTC 103	HEP-716	SK 3025	RT-115	ECG 159	WEP .717	ZEN 107
2N4404	NA	TS-3031	NA	ICC-S3031	IRTR-73	PTC 141	HEP-S3031	SK 3025	RT-115	ECG 129	WEP-242	NA
2N4405	NA	TS-3031	NA	ICC-S3031	IRTR-88	PTC 141	HEP-S3031	SK 3025	RT-115	ECG 129	WEP-242	NA
2N4406	NA	TS-3003	NA	ICC-S3003	IRTR-88	PTC 141	HEP-S3003	SK 3025	RT-115	ECG 129	WEP-242	NA
2N4407	NA	TS-3031	NA	ICC-S3021	IRTR-88	PTC 141	HEP-S3031	SK 3025	RT-115	ECG 129	WEP-242	NA
2N4409	RS276-2008	TS-0001	GE-18	ICC-S0001	IRTR-87	PTC 123	HEP-S0001	NA	RT-114	NA	WEP-712	ZEN 125
2N4410	RS276-2008	TS-0001	GE-18	ICC-S0001	IRTR-87	PTC 123	HEP-S0001	SK 3045	RT-110	ECG 154	WEP-712	ZEN 125
2N4411	NA	T-52	NA	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N4412	NA	T-51	GE-67	ICC-51	IRTR-88	PTC 103	HEP-51	SK 3025	RT-115	ECG 129	WEP-242	ZEN 101
2N4413	NA	T-716	GE-67	ICC-716	TR-20	PTC 103	HEP-716	SK 3114	RT-115	ECG 159	WEP-717	ZEN 107
2N4414	NA	T-51	GE-67	ICC-51	IRTR-88	PTC 103	HEP-51	SK 3025	RT-115	ECG 129	WEP-242	ZEN 101
2N4415	NA	T-716	GE-67	ICC-716	TR-20	PTC 103	HEP-716	SK 3114	RT-115	ECG 159	WEP-717	ZEN 107
2N4416	NA	T-802	GE-FET-2	ICC-802.	NA	PTC 151	HEP-802	SK 3112	RT-176	ECG 133	WEP-801	ZEN 123
2N4417	NA	T-801	GE-FET-2	NA	NA	PTC 152	NA	SK 3112	RT-176	ECG 133	WEP-801	NA
2N4418	NA	TS-0004	GE-20	ICC-S0004	NA	PTC 133	HEP-S0004	SK 3039	RT-113	ECG 108	WEP-56	ZEN 127
2N4419	NA	T-50	GE-20	ICC-50	TR-21	PTC 136	HEP-50	SK 3039	RT-113	ECG 108	WEP-56	ZEN 100
2N4420	NA	T-734	GE-20	ICC-734	IRTR-24	PTC 136	HEP-734	NA	RT-113	NA	WEP-723	ZEN 118
2N4421	NA	T-50	GE-20	ICC/50	TR-21	PTC 136	HEP-50	SK 3039	RT-113	NA	WEP-50	ZEN 100
2N4422	NA	T/734	GE-20	ICC-734	IRTR-24	PTC 136	HEP-734	NA	RT-113	NA	WEP-723	ZEN 118
2N4423	NA	NA	GE-21	ICC-52	NA	NA	NA	NA	RT-115	NA	WEP-717	NA
2N4424	NA	T-736	GE-20	ICC-736	TR-21	PTC 123	HEP-736	SK 3124	TR-102	ECG 123A	WEP-735	ZEN 120
2N4425	NA	ts-3024	GE-20	ICC-S3024	NA	PTC 123	HEP-S3024	SK 3124	RT-102	ECG 192	WEP-735	NA
2N4427	NA	TS-3008	GE-18	ICC-S3003	IRTR-87	PTC 143	HEP-S3008	SK 3024	RT-114	ECG 128	WEP-243	NA
2N4428	NA	TS-3001	GE-28	ICC-S3001	NA	NA	HEP-S3001	NA	RT-154	NA	NA	NA
2N4429	NA	NA	GE-28	NA	NA	NA	NA	NA	RT-154	NA	NA	NA
2N4430	NA	NA	GE-28	NA	NA	NA	NA	NA	RT-154	NA	NA	NA
2N4432	NA	T-736	NA	ICC-736	NA	PTC 123	HEP-736	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 120
2N4433	RS276-2009	T-734	GE-61	ICC-734	TR-24	PTC 132	HEP-734	SK 3018	RT-108	ECG 107	WEP-720	ZEN 118
2N4434	NA	T-709	GE-17	ICC-709	TR-21	PTC 132	HEP-709	SK 3117	RT-113	ECG 161	WEP-719	ZEN 105
2N4435	NA	T-709	GE-17	ICC-709	IRTR-65	PTC 132	HEP-709	SK 3117	RT-113	ECG 161	WEP-719	ZEN 105
2N4436	NA	T-736	GE-20	ICC-736	TR-21	PTC 123	HEP-736	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 120
2N4437	NA	T-736	GE-20	ICC-736	TR-21	PTC 136	HEP-736	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 120
2N4440	NA	NA	GE-28	NA	IRTR-55	NA	NA	NA	RT-154	NA	NA	NA
2N4441	NA	SR-1220	GEMR-4	ICC-R1220	NA	NA	HEP-R1220	NA	NA	ECG 5442	NA	NA
2N4442	NA	SR-1221	GEMR-4	ICC-R1221	NA	NA	HEP-R1221	NA	NA	ECG 5444	NA	NA
2N4443	NA	SR-1222	GEMR-4	ICC-R1222	NA	NA	HEP-R1222	NA	NA	ECG 5446	NA	NA
2N4444	NA	SR-1223	NA	ICC-R1223	NA	NA	HEP-R1223	NA	NA	ECG 5448	NA	NA
2N4449	NA	T-50	NA	ICC-50	NA	PTC 133	HEP-50	SK 3039	RT-113	ECG 108	WEP-56	ZEN 100
2N4450	NA	TS-0004	NA	ICC-S0004	NA	PTC 136	HEP-S0004	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 127
2N4451	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	NA	RT-126	ECG 106	WEP-52	ZEN 106
2N4452	NA	T-716	NA	ICC-716	NA	PTC 103	HEP-716	SK 3114	RT-115	ECG 159	WEP-717	ZEN 107
2N4453	NA	T-76	NA	ICC-76	NA	PTC 127	HEP-76	SK 3118	RT-126	ECG 106	WEP-52	NA
2N4851	RS276-2029	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129
2N4852	RS276-2029	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129
2N4853	RS276-2029	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129
2N4864	NA	t-241	NA	ICC-241	NA	NA	HEP-241	NA	NA	NA	WEP-241	NA
2N4867	NA	NA	GE-FET-1	NA	NA	PTC 152	NA	SK 3112	RT-176	ECG 133	WEP-801	NA
2N4868	NA	NA	GE-FET-1	NA	NA	PTC 152	NA	SK 3112	RT-176	ECG 133	WEP-801	NA
2N4869	NA	NA	GE-FET-1	NA	NA	PTC 152	NA	SK 3112	RT-176	ECG 133	WEP-801	NA
2N4870	RS276-2029	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129
2N4871	RS276-2029	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129

NA=NOT APPLICABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N4872	NA	T-52	NA	ICC-52	NA	PTC 127	HEP-52	SK 3118	RT-126	ECG 106	WEP-52	NA
2N4873	NA	TS-0004	NA	ICC-S0004	NA	PTC 133	HEP-S0004	SK 3039	RT-113	ECG 108	WEP-56	ZEN 127
2N4874	NA	TS-3008	NA	ICC-S3008	NA	PTC 143	HEP-S3008	NA	NA	NA	NA	NA
2N4875	NA	TS-3008	NA	ICC-S3008	NA	PTC 143	HEP-S3008	NA	NA	NA	NA	NA
2N4876	NA	TS-3008	NA	ICC-S3008	NA	PTC 143	HEP-S3008	NA	NA	NA	NA	NA
2N4877	NA	TS-3010	GE-66	ICC-S3010	NA	NA	HEP-S3010	NA	RT-150	NA	NA	ZEN 207
2N4878*	NA	T-738	NA	ICC-738	NA	PTC 123	HEP-738	NA	RT-109	NA	WEP-728	ZEN 121
2N4879*	NA	TS-0007	NA	ICC-S0007	NA	PTC 144	HEP-S0007	NA	NA	NA	WEP-712	NA
2N4880*	NA	T-729	NA	ICC-729	NA	PTC 121	HEP-729	NA	RT-109	NA	WEP-729	ZEN 115
2N4890	NA	T-708	GE-67	ICC-708	NA	PTC 141	HEP-708	NA	RT-115	ECG 129	WEP-242	NA
2N4891	NA	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129
2N4892	NA	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129
2N4893	NA	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129
2N4894	NA	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129
2N4898	RS276-2025	T-702	GE-69	ICC-702	IRTR-58	PTC 113	HEP-702	SK 3083	RT-133	ECG 218	WEP-700	NA
2N4899	RS276-2025	T-702	GE-69	ICC-702	IRTR-58	PTC 113	HEP-702	SK 3083	RT-133	ECG 218	WEP-700	NA
2N4900	RS276-2025	T-702	NA	ICC-702	IRTR-58	PTC 113	HEP-702	NA	RT-133	ECG 218	WEP-700	NA
2N4901	RS276-2027	T-705	NA	ICC-705	TR-29	NA	HEP-705	NA	NA	NA	WEP-S7001	NA
2N4902	NA	T-248	NA	ICC-248	TR-29	NA	HEP-248	NA	NA	NA	WEP-S7001	NA
2N4903	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	WEP-S5005	NA
2N4904	RS276-2027	T-705	NA	ICC-705	TR-29	NA	HEP-705	NA	NA	NA	WEP-S7001	NA
2N4905	NA	T-248	NA	ICC-248	TR-29	NA	HEP-248	NA	NA	NA	WEP-S7001	NA
2N4906	NA	T-248	NA	ICC-248	NA	NA	HEP-248	NA	NA	NA	WEP-S7001	NA
2N4907	NA	T-248	NA	ICC-248	NA	NA	HEP-248	NA	NA	NA	WEP-S7001	NA
2N4908	NA	T-248	NA	ICC-248	NA	NA	HEP-248	NA	NA	NA	WEP-S7001	NA
2N4909	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	WEP-S5005	NA
2N4910	RS276-2017	T-703	GE-66	ICC-703	NA	PTC 112	HEP-703	SK 3131	RT-150	ECG 175	WEP-241	NA
2N4911	RS276-2017	T-703	GE-66	ICC-703	NA	PTC 112	HEP-703	SK 3131	RT-150	ECG 175	WEP-241	NA
2N4912	RS276-2017	T-703	GE-32	ICC-703	NA	PTC 112	HEP-703	SK 3131	RT-150	ECG 175	WEP-241	NA
2N4913	NA	T-247	GE-19	ICC-247	TR-59	PTC 118	HEP-247	SK 3027	RT-131	ECG 130	WEP-247	NA
2N4914	NA	T-247	GE-19	ICC-247	TR-59	PTC 118	HEP-247	SK 3027	RT-131	ECG 130	WEP-247	NA
2N4915	NA	T-247	GE-14	ICC-247	NA	PTC 118	HEP-247	SK 3027	RT-131	ECG 130	WEP-247	NA
2N4916	RS276-2023	T-52	GE-22	ICC-52	TR-20	PTC 103	HEP-52	SK 3025	RT-115	ECG 159	WEP-717	NA
2N4917	RS276-2023	T-52	GE-21	ICC-52	NA	PTC 103	HEP-52	SK3114	RT-115	ECG 159	WEP-717	NA
2N4918	RS276-2027	T-700	GE-29	ICC-700	NA	NA	HEP-700	NA	RT-153	ECG 185	WEP-WS5007	NA
2N4919	RS276-2026	T-246	GE-29	ICC-246	IRTR-77	NA	HEP-246	NA	RT-153	ECG 185	WEP-WS5007	ZEN 203
2N4920	NA	TS-5006	GE-69	ICC-S5006	NA	NA	HEP-S5006	NA	RT-153	ECG 185	WEP-WS5007	NA
2N4921	RS276-2018	T-245	GE-28	ICC-245	NA	PTC 110	HEP-245	NA	RT-152	ECG 184	WEP-WS5003	ZEN 202
2N4922	RS276-2018	T-245	GE-28	ICC-245	NA	PTC 110	HEP-245	SK 3054	RT-152	ECG 184	WEP-WS5003	ZEN 202
2N4923	RS276-2018	T-245	GE-28	ICC-245	NA	PTC 110	HEP-245	NA	RT-152	ECG 184	WEP-WS5003	ZEN 202
2N4924	NA	T-713	GE-27	ICC-713	NA	PTC 144	HEP-713	SK 3045	RT-110	ECG 154	WEP-712	NA
2N4925	NA	T-712	GE-32	ICC-712	IRTR-78	PTC 117	HEP-712	SK 3045	RT-110	ECG 154	WEP-712	ZEN 205
2N4926	NA	T-712	GE-27	ICC-712	IRTR-78	PTC 117	HEP-712	SK 3045	RT-110	ECG 154	WEP-712	ZEN 205
2N4927	NA	T-712	GE-27	ICC-712	IRTR-78	PTC 117	HEP-712	SK 3045	RT-110	ECG 154	WEP-712	ZEN 205
2N4928	NA	T-710	NA	NA	IRTR-88	PTC 127	NA	SK 3025	RT-115	ECG 129	WEP-242	NA
2N4932	NA	NA	NA	NA	NA	PTC 128	NA	NA	NA	NA	NA	NA
2N4934	RS276-2011	T-56	NA	ICC-56	IRTR-66	PTC 133	HEP-56	SK 3039	RT-113	ECG 108	WEP-56	ZEN 104
2N4935	RS276-2011	T-56	NA	ICC-58	NA	PTC 133	HEP-56	SK 3039	RT-113	ECG 108	WEP-56	ZEN 104
2N4936	NA	T-56	NA	ICC-738	NA	PTC 133	NA	SK 3039	RT-113	ECG 108	WEP-56	ZEN 121
2N4937*	NA	T-715	GE-21	ICC-715	NA	PTC 127	HEP-715	NA	RT-115	NA	WEP-715	ZEN 106
2N4938*	NA	T-715	GE-21	ICC-715	NA	PTC 127	HEP-715	NA	RT-115	NA	WEP-715	ZEN 106
2N4939*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	NA	RT-115	NA	WEP-715	ZEN 106
2N4940*	NA	T-715	GE-21	ICC-715	NA	PTC 127	HEP-715	NA	RT-115	NA	WEP-715	ZEN 106
2N4941*	NA	T-715	GE-21	ICC-715	NA	PTC 127	HEP-715	NA	RT-115	NA	WEP-715	ZEN 106
2N4942*	NA	T-715	NA	ICC-715	NA	PTC 127	HEP-715	NA	RT-115	NA	WEP-715	ZEN 106
2N4943	NA	T-714	NA	ICC-714	IRTR-87	PTC 144	HEP-714	SK 3024	RT-114	ECG 128	WEP-243	NA
2N4944	NA	T-714	GE-20	NA	IRTR-87	PTC 123	NA	SK 3024	RT-114	ECG 128	WEP-243	NA
2N4945	NA	T-714	GE-18	NA	IRTR-87	PTC 123	NA	SK 3024	RT-114	ECG 128	WEP-243	NA
2N4946	NA	T-714	GE-20	ICC-714	IRTR-87	PTC 123	HEP-714	SK 3024	RT-114	ECG 128	WEP-243	NA
2N4948	NA	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129
2N4949	NA	T-310	NA	ICC-310	NA	NA	HEP-310	NA	NA	NA	WEP-310	ZEN 129
2N4950	NA	NA	GE-20	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N4951	NA	TS-0004	GE-20	ICC-S0004	NA	PTC 136	HEP-S0004	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 127
2N4952	NA	TS-0004	GE-20	ICC-S0004	NA	PTC 136	HEP-S0004	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 127
2N4953	NA	T-736	GE-10	ICC-736	TR-2	PTC 136	HEP-736	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 120
2N4954	NA	TS-0004	GE-10	ICC-S0004	TR-2	PTC 136	HEP-S0004	SK 3124	RT-102	ECG 123A	WEP-735	ZEN 127
2N4955	NA	T-737	NA	ICC-737	NA	NA	HEP-737	NA	RT-109	NA	WEP-735	NA
2N4956*	NA	T-724	NA	ICC-724	NA	PTC 121	HEP-724	NA	RT-105	NA	NA	ZEN 112
2N4960	NA	TS-3001	NA	ICC-S3001	IRTR-87	PTC 123	HEP-S3001	SK3024	RT-114	ECG 128	WEP-243	NA
2N4961	NA	TS-3002	NA	ICC-S3002	IRTR-87	PTC 123	HEP-S3002	SK 3024	RT-114	ECG 128	WEP-243	NA

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

NA=NOT AVAILABLE

(continued next month)

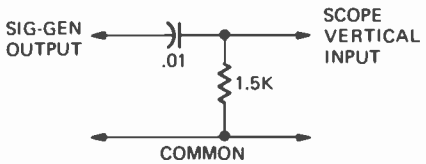
RE's Service Clinic

RC networks and different waveforms

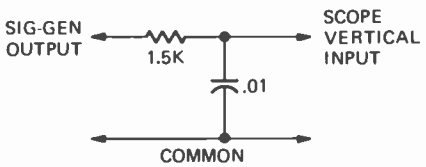
The effects are weird if you don't know what to expect

by JACK DARR
SERVICE EDITOR

WHILE WORKING IN MY LABORATORY recently, doing research on the behaviour of special test signals. (Translation; I was goofing off in the shop, playing with a function generator!) I ran across some interesting things.



DIFFERENTIATOR



INTEGRATOR

FIG. 1

They interested me, anyhow. I knew that you'd change a waveform if you fed it through an R-C network. However, I got one result that wiped me out. After a lot of digging, I found out why. See if *you* can predict the results, and then explain 'em.

I used the three standard signals from a function generator; sine, square and triangular waveforms. I fed these through the two stock R-C network hook-ups; a differentiator and an integrator. A quick look at the schematic of any kind of electronic equipment will show you lots of these things.

Figure 1 shows the circuits used. Look at these. Now, draw your idea of what the *output* waveform looks like, and see if you can explain it. After you get through, read on and see what I actually got, and my idea of why. Have fun!

The answers.

Figure 2 shows the inputs to the differentiator circuit and the output waveforms I saw on the scope.

1. Almost everybody should get this one, or get close. The differentiator makes a spike waveform from a square wave. This is used in many pulse generator circuits.

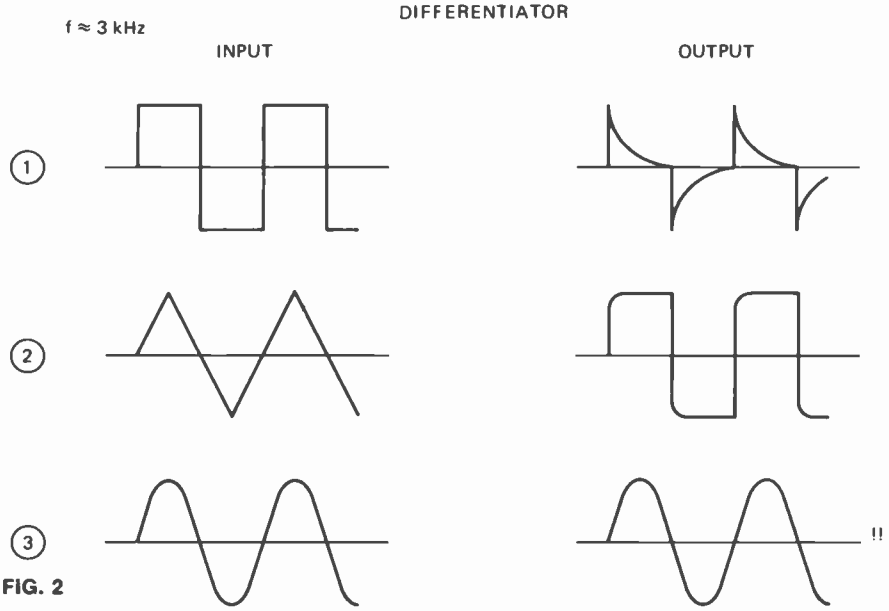


FIG. 2

2. This one fooled me. However, you can see what happened. The time constant is long enough so that the capacitor reaches full charge. So, it rounds off the leading edge of the square wave.

3. This is the wipe-out. What happended? *Nothing.* Output waveform

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.

exactly the same as the input! We'll explain that in a minute. Go on to Figure 3. This is the integrator.

4. Surprise! An integrator makes a triangular wave out of a square wave. This is used in function generators to develop a triangular wave.

5. Look at this one. Integrating a triangular wave makes a *sinewave.* Another method used in function generators, although theirs is much more elaborate.

6. Here we go again. Nothing happens, just as before.

Wha' Hoppen?

How come this reaction? Frankly, I expected to see a change in waveform in all of them. When the sinewave came through undisturbed, I couldn't believe it. Back to the books. Here is the best explanation I could find, after quite a bit of digging around.

As briefly as possible, both square and triangular waves can be considered as being made up of innumerable *harmonics!* The charging of the capacitor and the action of the resistor affects these; the waveform is distorted, although its fundamental frequency is still the same.

The really odd effect is the reaction on the sinewave. Why doesn't the R-C network upset it, as it does all others? Here's what they say.

A sinewave, especially one with very low distortion, is considered as a "pure signal." That is, it's *not* made up of harmonics, but is just a single frequency, theoretically *without* any harmonics at all! So, you'll see practically no effect on the waveform. Most of what you will see will be only a small loss in amplitude.

You can try this yourself, with any audio signal generator and scope. It's fascinating. Try different values for R and C, and different frequencies. If you don't have a square-wave signal generator, feed the sinewave output into a pair of low-voltage Zeners, tied in parallel and reversed. This will make a fair square wave. You can get the triangle by feeding the square wave into a separate integrator, and then feeding the resultant into another R-C network. *(continued on page 72)*

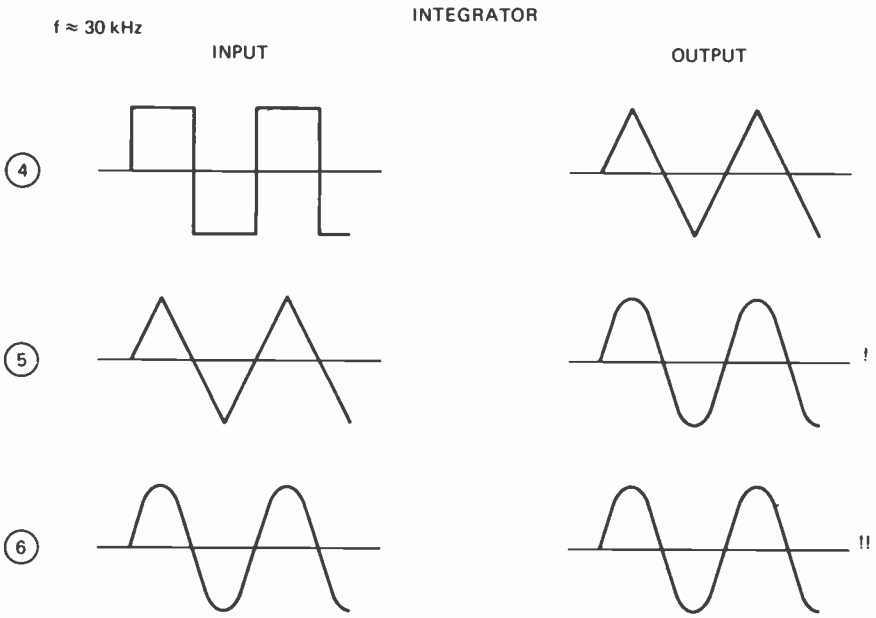


FIG. 3

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Circle 18 on reader service card

SERVICE CLINIC
(continued from page 70)

reader questions

THE "REGAUSSING" COIL

Originally, this Motorola TS-914 chassis came in with the circuit-breaker tripping. Replaced a bad diode in the voltage-doubler—no help. The resistor in parallel with the degausser coil was open and I replaced it. When I turned the set on, there was a spark from somewhere. After this the breaker didn't trip any more.

The purity is lousy. The best I can get is a 12-inch red circle in the middle with blotches around the edge. I cooked it for 6 hours. While this was going on, I noticed that the purity began to get worse around the edges. Manual degaussing will clear it up, but it comes back in a few hours.

I'm at a loss. HELP!—D.S. Oregon, OH.

The trouble is in the auto degausser circuit. It is obviously "re-gaussing" the tube! In this chassis, the most likely suspect would be the thermal degaussing switch. This *could* have been where your arc was. If the points have welded, this leaves the coil in-circuit all the time, and this *causes* impurity.

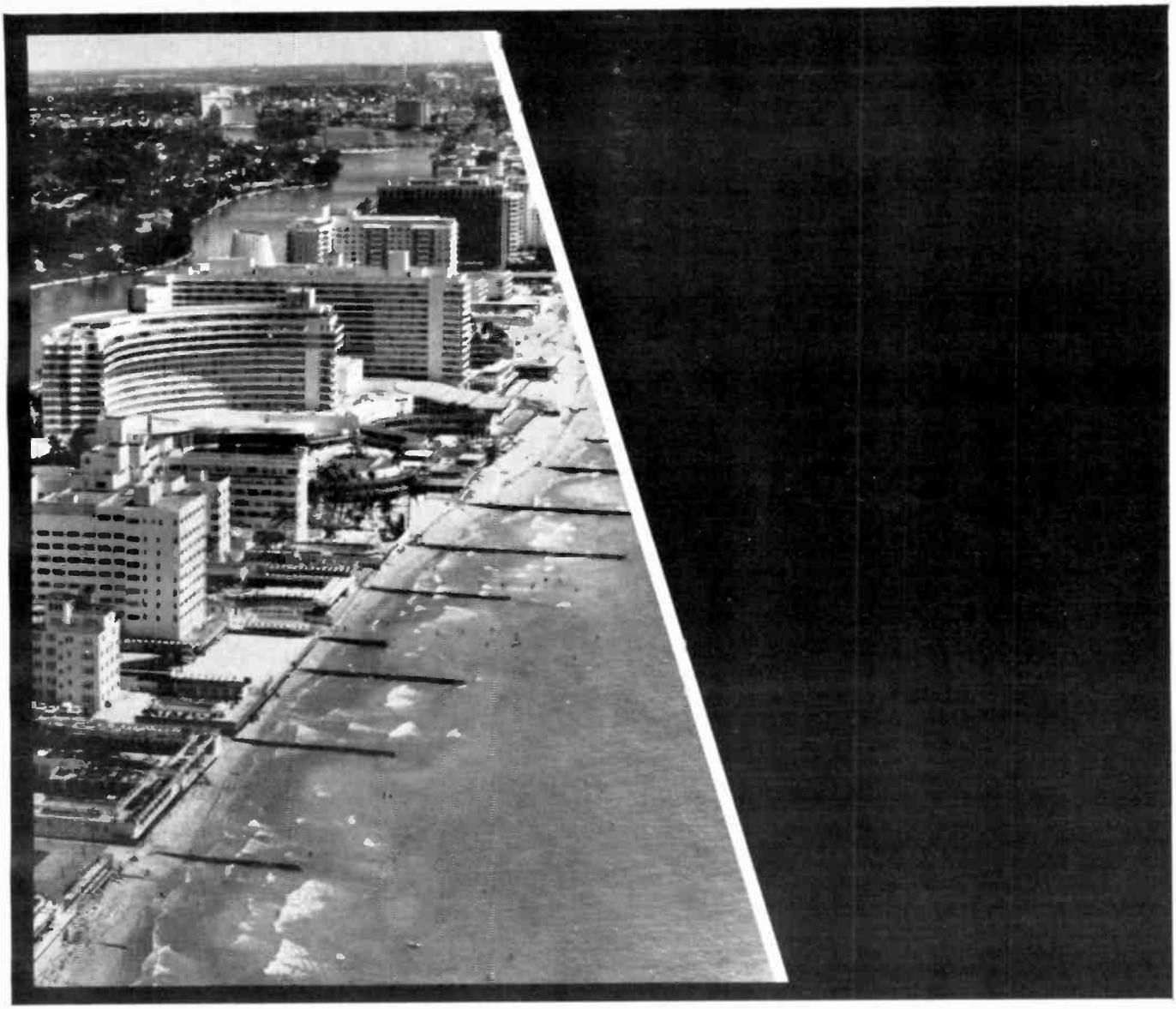
NO SNOW, THAT'S BAD

This Sylvania DO3 has been pretty well overhauled; tuner, new filters and so on. I'm still not happy with it. The age control doesn't have the proper effect. Also, I have no snow on unused channels, nor with the antenna off. Distant stations won't come in, though the owner says they used to. Colors aren't good, even on local stations. What do you think?—R.D., Panama City, FL.

I think you're "losing it," somewhere. This set obviously doesn't have enough gain. The no-snow symptom is almost always an indication of very poor rf or i.f. gain. This could be due to one of two things.

Excessive negative age voltage could be holding the gain down. This is the easy one. Clamp the age to +18 volts. If this sounds funny in a tube set, remember that the 1st i.f. cathode is +21 volts above ground so that the actual age bias on the tube is a −3 volts. If this brings the snow and the colors back, check out the dc voltages

(continued on page 78)



Our town

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Circle 20 on reader service card

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Edward J. Dulaney, Scottsbluff, Nebraska, (above and at right) earned his CIE Diploma in 1961, got his FCC License and moved from TV repairman to lab technician to radio station Chief Engineer. He then founded his own two-way radio business. Now, Mr. Dulaney is also President of D & A Manufacturing, Inc., a $1,000,000 company building and distributing two-way radio equipment of his own design. Several of his 25 employees are taking CIE courses. He says: "While studying with CIE, I learned the electronics theories that made my present business possible."

Two-way radio is booming. There are already nearly seven million two-way transmitters for police cars, fire department vehicles, taxis, trucks, boats, planes, etc., and Citizens Band uses. And the number keeps growing by the thousands every month. Who is going to service them? You can – if you've got the know-how!

Why You'll Earn Top Pay

One reason is that the United States Government doesn't permit anyone to service two-way radio systems unless he's *licensed* by the FCC (Federal Communications Commission).

Another reason is that when two-way radio men are needed, they're *really* needed! A two-way radio *user* must keep those transmitters operating at all times. And, they *must* have their frequency modulation and plate power input checked at regular intervals by licensed personnel to meet FCC requirements.

As a licensed man, working by the hour, you would usually charge at least $5.00 per hour, $7.50 on evenings and Sundays, plus travel expenses.

Or you could set up a regular monthly retainer fee with each customer. Your fixed charge might be $20 a month for the base station and $7.50 for each mobile station. Studies show that one man can easily maintain at least 135 stations – averaging 15 base stations with 120 mobiles! This would add up to at least $12,000 a year.

Be Your Own Boss

There are other advantages, too. You can become your own boss – work entirely by yourself or gradually build your own fully staffed service company. Of course, we can't promise that you will be as successful as Ed Dulaney, or guarantee that you'll establish a successful two-way radio business of your own, but the opportunities for success are available to qualified, licensed men in this expanding field.

How To Get Started

How do you break in? This is probably the best w
1. Without quitting your present job, learn enough ab electronics fundamentals to pass the Governm FCC exam and get your Commercial FCC Lice
2. Then get a job in a two-way radio service shop "learn the ropes" of the business.
3. As soon as you've earned a reputation as an ex there are several ways you can go. You can *out* and start signing up and servicing your own customers. You might become a franchised service representative of a big manufacturer and then start getting into two-way radio sales.

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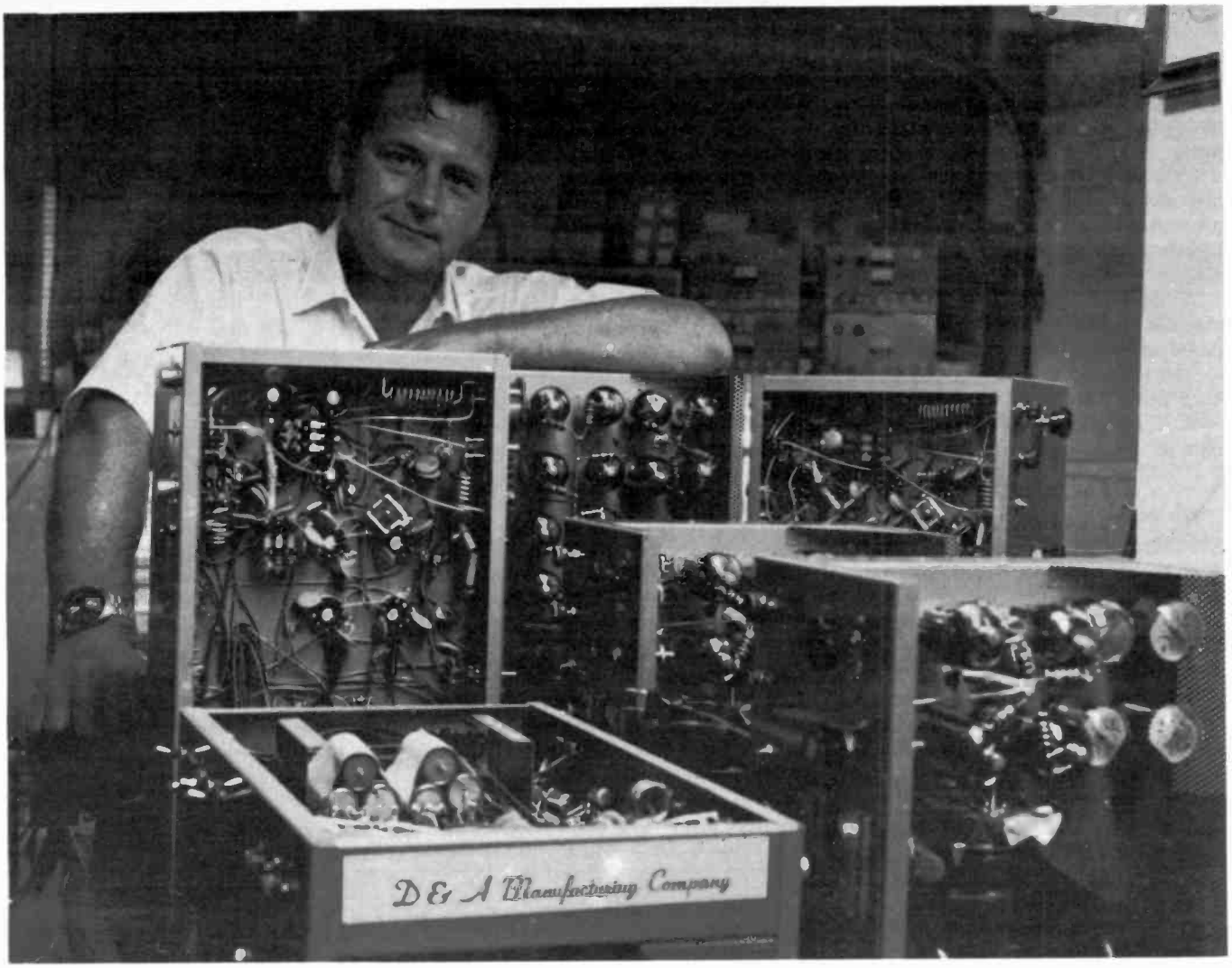

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RE-38

Circle 21 on reader service card

SERVICE CLINIC

(continued from page 72)

around the agc tube. Remember that the schematic voltages are read with no signal. These are all critical voltages.

Second possibility is a problem of low gain in either the rf amplifier or possibly the 1st or 2nd video i.f. stages. Check all dc voltages and the tubes, etc.

While you're there, check the 5.6-megohm resistor from the rf agc terminal to +265 volts. This is supposed to provide a small positive voltage to keep the agc from going too far negative. If it's open, you'll often get the type of symptom you have.

G-E M110YBG HINT

On the G-E M110YBG and other SY chassis models, they use a copper strip bolted to the top front horizontal bar of the chassis as the ground for the Aquadag coating on the picture tube. If the Aquadag burns off or has poor contact here, it will arc. This will radiate and mess up the horizontal sync. Fix this ground. Use a spring, or another thin strip like that used to ground the tuner. I've done this on several of these sets.

Thanks very much to Paul Fleming of Dallas, Texas for this one. **R-E**

APPLIANCE CLINIC

(continued from page 24)

covered, this should read approximately 15,000 ohms or more. Now uncover the cell and let light hit it. The resistance should drop to somewhere around 1500 to 2000 ohms. The higher the intensity of the light, the lower the resistance. The relay should now close if power is applied to the unit. If it won't move, turn the power off and connect a jumper clip lead across the photocell. The armature should now close unless the coil has some shorted turns.

Figure 2 shows the schematic of a larger unit, used with the mercury-vapor lamps. Note the similarity. This one has a temperature-sensitive resistor mounted in shunt with the photocell and coil. Some units have a sensitivity control, so the lamp can be turned on at any desired level of outside light. (Some of these can be so sensitive that they turn on when the weather is fairly cloudy!)

The control unit in Fig. 1 is practically instantaneous. With the larger units in Fig. 2 and mercury-vapor lamps, there will be about one or two second delay. This isn't due to the control unit but rather the characteristics of a mercury-vapor lamp. These are actually "arc lamps," and it takes

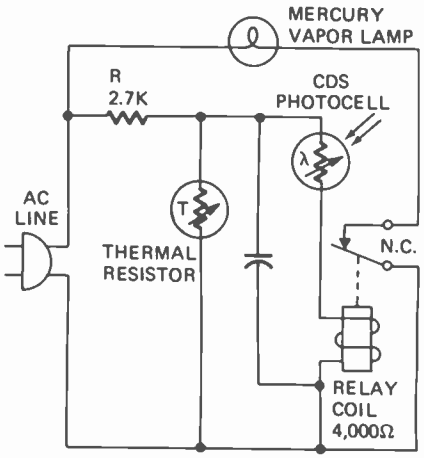

FIG. 2

a little time for the arc to form.

This delay will be almost impossible to notice during normal operation. However, during a violent thunderstorm with its associated bright flashes of lightning, you may notice the lamp going off. It may stay off for a moment, especially after a very bright flash. The photocells in this case are said to be temporarily "blocked". This is caused by very high-intensity light, just as human vision is temporarily blinded. This won't do any permanent damage, unless of course the unit takes a direct lightning hit. **R-E**

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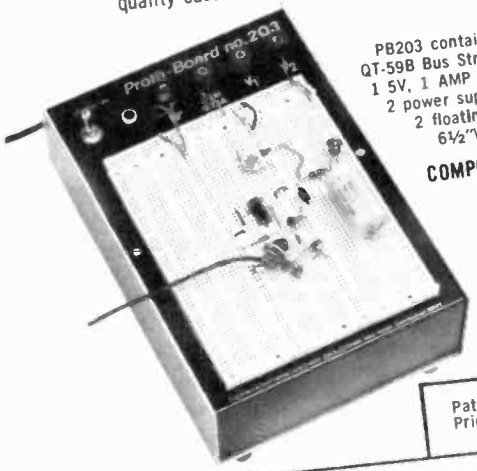

PB203 contains: 3 QT-59S Sockets; 4 QT-59B Bus Strips; 1 QT-47B Bus Strip; 1 5V, 1 AMP regulated power supply; 2 power supply 5-way binding posts; 2 floating binding posts; 9¾"L x 6½"W x 2¾"H. Weight: 5 lbs.

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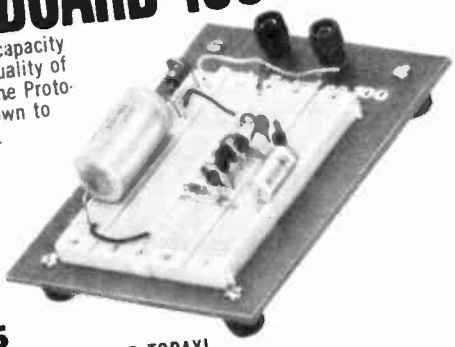

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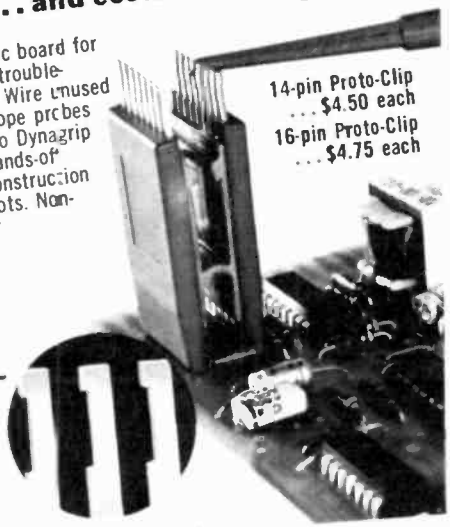

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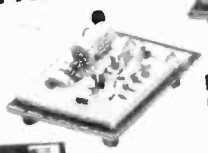

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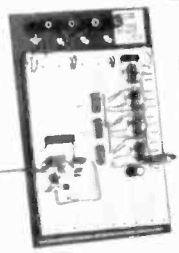

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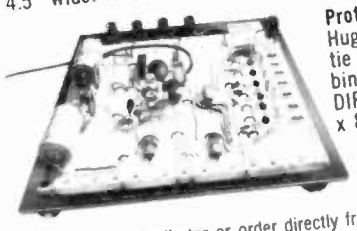

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Circle 24 on reader service card

BUILD A PHOTOFLASH

(continued from page 37)

Series capacitor bank forming operation

Plug in the ac power line and turn the power switch to ON. Before triggering the photoflash unit, allow the unit to charge for no less than three hours, overnight is even better.

After the minimum charging period, or overnight, attach a camera sync cord to the camera sync socket and with a pin or small piece of wire, short the end terminals to trigger the flash. Then allow 3 to 7 seconds for the recycle power to build-up. Then re-trigger the unit for approximately 30 flashes. The combination of 3 hour charge and repeated flashing will complete the forming operation and the flash unit will be ready to use with your camera.

Always trigger your flash unit several times before beginning to take pictures to assure maximum power output. Unused units will gradually de-form with age, and it is recommended that the forming operation be followed once every two to three months for better operation and to extend the life of the capacitors.

Operation

Bare-bulb operation, without a reflector, usually has a guide number of 30 for a 200 watt-second power output, and as high as 150 with reflector for ASA 25 film. Guide numbers are just that . . . a guide to use as a starting point for proper exposure. I recommend running a test film of varied exposures and shutter speeds to determine the proper guide number for your type of use. This involves shooting a series of pictures on a good resolution film, one rated at ASA 30 to ASA 65. Bracket your exposures 4 stops up and 4 stops down from f-8 at a shutter speed of 1/100-second.

Always use a maximum shutter speed of 1/60th of a second for cameras with focal plane shutters since the photoflash triggers at X or zero-delay shutter setting.

Troubleshooting the photoflash unit.

If you have properly made the circuit boards and installed each component properly, there should be no difficulty encountered in operating the unit. Usually, during the initial forming operation, considerable heat will be radiated from R1, and the possibility of the fuse blowing exists. This can be caused by excessive leakage of capacitors C3 and C4 that will correct its-self after completing the forming operation. It can also be caused by connecting the polarity of the capacitors incorrectly. Should your fuse blow, check the capacitor polarity FIRST.

Should the flash tube fail to fire, remove the flash tube from it's socket and measure across the socket pins with a DC Voltmeter. The positive lead of the voltmeter to pin 2 and the negative lead to pin 4. It should measure 450 volts. Should you be unable to measure the voltage; turn off power switch, open top, and check the following:

check 1	Open fuse
check 2	Open R1
check 3	Incorrect polarity of capacitors C3 and C4
check 4	Open or shorted D1, D2, D3
check 5	Incorrect polarity of capacitors C1 or C2
check 6	Open connection between power circuit and trigger circuit

For those who would like to construct a bare bulb electronic photoflash unit but would prefer to assemble a kit, there is a kit for the Uniflash barebulb photoflash produced by Mitchell Enterprises, P.O. Box 1372, San Francisco, CA. 94101. **R-E**

NEW IN DVM's

(continued from page 49)

COLD-CATHODE DISPLAY TUBES and other similar lamps indicate voltage, current and resistance measurements on the *Heathkit model IM-102* 3½-digit dmm. Most voltage and current ranges have overrange capability and an overrange indicator is provided. Polarity of dc voltage and current is automatically detected and displayed. Decimal-point positioning is automatic on each range.

Dc voltage ranges are 200 mV, 2, 20, 200 and 1000 volts. Input impedance is greater than 100 megs on the first range, greater than 1000 megs on the second and 10 megs on the 20, 200 and 1000-volt ranges. Accuracy is ±0.2% ±1 digit. Overrange capability 20%—subject to overload protection limits. Resolution (200-mV range) is 100 μV.

Ac voltage ranges same as dc; input impedance is 1 megohm/150 pF. Overload protection 250 Vrms on lowest two ranges; 500 Vrms on the top three. Accuracy ranges from ±0.75% ±1 digit to ±1.5% ±1 digit.

Current ranges (dc and ac): 200 μA, 2, 20 and 200 mA and 2 A. Accuracy ±0.3% ±1 digit on dc, ±1.0% ±1 digit on ac.

The *IM-102* is 3 × 7.9 × 7 in., 4 lbs. $239.95.

AUTO-RANGING AND LOW-POWER OHMS are but two of the features of the *Keithley model 168* dmm. The five functions give you the capabilty of measuring 100 μV to 1000 Vdc, 100 μV to 500 Vac, 100 nA to 1 amp ac and dc and 100 milliohms to 20 megohms. Input resistance is 10 megs on dc and 9 megs shunted by 90 pF on ac.

The *168* may be powered by line voltage or rechargeable NiCad batteries when the model *1688* rechargeable battery set is installed.

With this dmm, you can turn on a semiconductor junction to see if it is good; or measure resistance in-circuit without turning on associated semiconductors. The 1.8 volts across the test prods, in the HIGH-OHMS mode, is enough to turn on most semiconductors. In the LOW-OHMS mode, a maximum of 180 mV is applied to the circuit under test so semiconductors are not turned on.

This dmm operates from 90–110, 105–125, 195–235 or 210–250 V, 50–60 Hz, 6 W. It is 3½ x 9¼ x 10¾ in., 3½ lbs. $299, $359 with rechargeable battery pack installed.

ONE-YEAR BATTERY LIFE from a standard 9-volt transistor battery and liquid-crystal display are two novel features of *Danameter model 2000*, a product of Dana Laboratories.

Voltage ranges (ac and dc) are 2, 20, 200 and 1 kV with 1 mV resolution. Input impedance is 10 megohms on dc and 2 megs shunted by 40 pF on ac. Accuracy is ±0.5% of reading +.05% of range on 2-volt dc range; ±0.75% of reading +.05% of range on the remaining dc ranges.

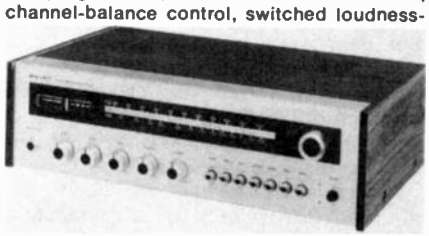
Direct current ranges are 20 μA, 200 mA and 2 A with 0.01 μA resolution. Resistances ranging from 200 ohms to 200 megohms are covered in four 100:1 ranges. Resolution is 0.1 ohm. The Danameter 2000 is $195. **R-E**

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.

RECEIVER, *model R36S* features 30 watts per channel into 8 ohms, both channels driven from 20-20,000 Hz at less than 0.5% distortion. FM performance includes IHF sensitivity of 1.9 μV, capture ratio of 2.5 dB and midband stereo separation of 35 dB minimum.

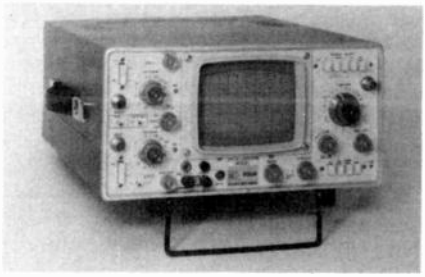
Operating features include channel selector, ganged bass, treble and volume controls, channel-balance control, switched loudness-



compensation, mono/stereo mode, tape monitor facilities, muting and high-frequency filter switches, speaker connections and switching for two sets of stereo speakers. Separate signal-strength and center-channel tuning meters are included. Rear panel features include choice of 300-ohm antenna strip or 72-ohm antenna jack, DIN jacks and multiple voltage selector for foreign operation, speaker fuses and extra accessory power outlets. Frequency response: 25-15,000 Hz. 5½ x 18 x 13 in.; 24 lbs.; $329.95.—**H. H. Scott, Inc.,** 111 Powdermill Road, Maynard, MA 01754.

Circle 31 on reader service card

OSCILLOSCOPE, *model 530A.* Medium-band width, dual-trace portable scope features internal parallax-free 6 × 10 cm CRT graticule, 1-mV sensitivity on both vertical channels with a full 25-MHz bandwidth, five display

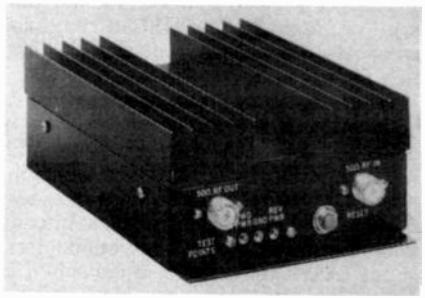


modes and stable, high-speed gated trigger capable of locking any signal from dc to 40 MHz, including TV line and frame. Special operating requirement such as dc trigger or ×5 magnification is obtained by pressing the appropriate button. Also incorporates internal delay lines and offers optional battery pack. $1,150.00—**Scopes Unlimited, Inc.,** 1928 South Anaheim Blvd., Anaheim, CA 92805.

Circle 32 on reader service card

AMPLIFIERS, *models PA-2938 & PA-2939.* Both models help to boost low-power mobile or base station and give it increased talk power and greater operating range. Operation is automatic and self-protecting. Balanced emitters are tested for all mismatched conditions. Extra heavy heatsinking is used to provide extended duty cycle in the course of everyday use.

Built-in low-pass filter attenuates harmonics in excess of FCC requirements. SWR pro-

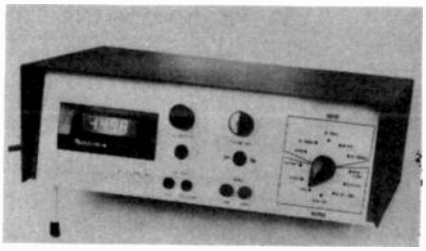


tection has reset button to reactivate power amplifier after shutdown. Frequency range: 150 MHz-175 MHz. Power input: *PA-2938,* 10 watts; *PA-2939,* 25 watts. Power output: *PA-2938,* 80 watts; *PA-2939,* 80 watts.—**Sonar Radio Corp.,** 73 Wortman Avenue, Brooklyn, NY 11207.

Circle 33 on reader service card

POWER SOURCE MONITOR, *model VS-200* contains five regulated power supplies. Has dual ±15 V, 110 mA supply for most common linear amplifier applications. Has dual polarity, tracking ±200 mA power supply that can be controlled between 50 mV and 20 V. Also has 0-200 mV, 10-mA supply whose polarity can be reversed.

3½ digit liquid-crystal meter is 0.5" tall; monitors the output of any power supply; can

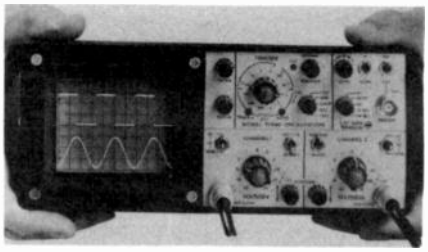


be switched by front panel control to monitor the outputs of standard power supplies; can also be used to measure voltages produced by other devices; accuracy is 0.2%. Automatic decimal point placement; automatic short-circuit shutdown; unit doubles as digital voltmeter. 5 x 15 x 11 in.; $395.00.—**Thinc, Technical Hardware Inc.,** P.O. Box 3609, Fullerton, CA 92634.

Circle 34 on reader service card

OSCILLOSCOPE, *model PS940A.* Mini-portable scope features computerized triggering. TTL logic circuit eliminates the need for front panel adjustment to achieve a stable trace display. DC trigger mode most often used in digital test efforts allows user to make vertical position adjustments without losing sync.

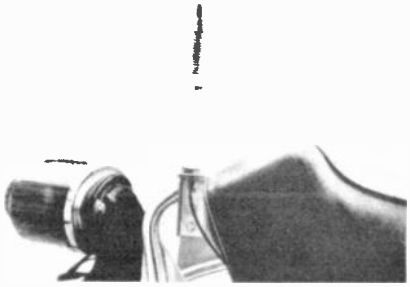
Twenty one sweep ranges, 20 MHz bandwidth, 10 mV/div sensitivity, built-in delay line for use in viewing pulse leading edges, full dual-trace switching capability, algebraic waveform as well as ac, low-frequency reject



and high-frequency reject trigger modes. Screen size is full 8 × 10 divisions with each division equal to ¼". Battery recharging circuitry is included within chassis. Operates from battery, ac or dc powered; battery charge indicator. 3½ x 8½ x 12 in.; 9.5 lbs.; $1,095.00. **Vu-data Corp.,** 7170 Convoy Court, San Diego, CA 92111.

Circle 35 on reader service card

CB ANTENNA, *model M-306* is designed for use on motorcycles, fiber-glass bodied vehicles, boats, snowmobiles and other vehicles that do not have enough metallic ground area to assure good operation of a standard CB antenna. Secret of the unit's performance is its half-wave-length electrical design with both base-and-whip-loading coils. Heavy-



duty spring above the base loading coil provides shock protection.

Entire antenna is designed for reliable operation under high vibration conditions. Has white fiber glass whip and streamlined chrome spring assembly. Supplied complete with hardware for a variety of installation requirements that include mounting on vertical or horizontal surfaces or on round bars up to ¾" in diameter. $30.95—complete with coax cable and connector.—**Antenna Specialists Co.,** 12435 Euclid Avenue, Cleveland, OH 44106.

Circle 36 on reader service card

SOLDERING IRON, *D I Line.* Heater and handle with two-conductor cord set and safety plug are double insulated; meet latest safety standard of OSHA and are UL listed. Modu-

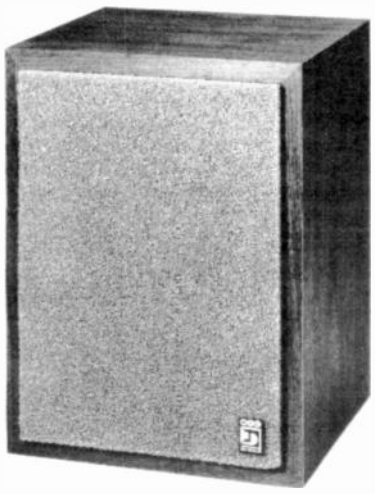
lar in concept. Four rugged stainless steel heaters and three heat ranges provide flexibility for virtually every soldering job. Easy-to-use, lightweight and compact design. Han-

dle is molded of durable plastic with finger-ease cool drip.—**Ungar,** Div. of Eldon Industries, Inc., 233 East Manville, Compton, CA 90220.

Circle 37 on reader service card

SPEAKER, *Formula 1* is a two-way system that is designed as the main speaker in budget systems or as a second stereo pair. Frequency response is 35—17,500 Hz; impedance is 8 ohms. For use with low-power amplifiers or receivers, yet it can handle as much as 50 rms watts per channel.

Bass energy is boosted as woofer's backwave energy travels through Venturi-coupled

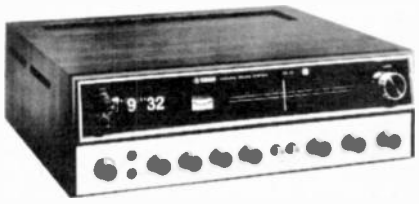


path that functions as acoustic transformer. In that path, air motion velocity increases over broad band of bass frequencies. "Biconex" horn/compression driver assembly is used to cover mid-range and treble frequencies. 15 × 10⅞ × 10 in.; $74.95 each.—**BIC Venturi, British Industries Co.,** Westbury, NY 11590.

Circle 38 on reader service card

4-CHANNEL RECEIVER, *model CS70R* offers choice of 4-channel systems—discrete or matrix—or 2-channel stereo; full-featured digital clock that can be pre-set to turn complete system on or off; power switch that is actually a key that can lock the system in the off position.

Tuner features: FET FM front end, i.f.

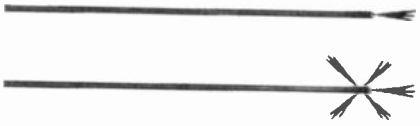


amplifier with an IC and three solid-state filters, IC FM multiplex demodulator, ultrasensitive AM tuner section. Preamplifier sec-

tion has 11 controls that include separate bass, treble and loudness controls; inputs for tape, phono and aux.; accommodates FM wireless microphone; stereo and 4-channel headphone jacks. Amplifier section has bridged transformerless circuit, power output in 2-channel mode 22 + 22 watts rms (each channel driven) into 8 ohms at 1000 Hz; in 4-channel mode 12 × 4 watts rms (each channel driven) into 8 ohms at 1000 Hz; total harmonic distortion in 2- and 4-channel modes is less than 1% at rated power; power bandwidth in all modes is 30 to 40,000 Hz; frequency response is 40 to 20,000 Hz + 3 dB — 3 dB. $370.00.— **Yamaha**, 6600 Orangethorpe Avenue, Buena Park, CA 90602.

Circle 39 on reader service card

SERVICE AID, *Omni-Spra*, is a nozzle extension that sprays in a 360° circle as well as out the end—used for cleaning the backs



and sides of components as well as the fronts. New aid is being packed with all cans of the company's "Blue Shower." For free sample, send note to attention of Jean Main. —**Tech Spray**, P.O. Box 949, Amarillo, TX 79105.

Circle 40 on reader service card

LEAD BENDER, *model N-300* eliminates measurement and trial and error bending of component leads. Matching pointers with eyelet holes in circuit boards by spining knurled wheel with thumb automatically spaces bends for insertion of component into board. Bends are formed by pressing

leads against sides of pointers with thumb and forefinger. All axial lead components are accommodated, e.g., resistors, capacitors, diodes, transistors, inductors, etc. up to ½ in. diameter x 1½ in. long with maximum distance between inside of bends of 1.725 in. $32.50—complete with spare set of lead guides.— **Harwil Co.**, 903 Colorado Avenue, Santa Monica, CA 90401.

Circle 41 on reader service card

TURNTABLE, *model SR-212*. Two-speed (33⅓, 45 rpm) unit features a heavy belt-driven 12" aluminum alloy platter. Motor is a stable 4-pole synchronous design that maintains constant speed regardless of line voltage variations. Cueing device is damped going up as well as down. No chance for tone-arm snap-up and loss of correct position when just a pause in play is desired.

All you have to do is move tone-arm over the record groove and nudge cueing lever. Arm floats down over the groove and lifts up again when the side is completed; arm is an S-shaped design with anti-skate counter

balance in addition to conventional stylus force counter balance weight. Comes complete with walnut base. Connection from arm

to amplifier is low-capacitance lead that is suitable for CD-4 applications. $149.95.—**Sansui Electronics Corp.,** 55-11 Queens Blvd., Woodside, NY 11377.

Circle 42 on reader service card

DIGITAL MULTIMETER, *model 2180.* 3½ digit, bipolar instrument has all five standard multimeter functions plus five decibel measurement ranges extending from −60 dB to +56 dB. Basic accuracy of 0.1% and resolution of 100 μV; operates from either ac line or internal rechargeable batteries.

Functions are pushbutton selected and include ac volts, dc volts, ac current, dc current, resistance and decibels. Its 31 measuring ranges are selected by rotary switch with additional battery check position that allows internal battery conditions to be monitored. Automatic integral battery charging circuit will maintain batteries at full charge as long as instrument is connected to ac line. "HT Converter" A-D conversion technique,

coupled with LSI, has enabled reduction of components. Circuit boards, IC's and displays are plug-in. $395.00.—**United Systems Corp.,** 918 Woodley Road, Dayton, OH 45403.

Circle 43 on reader service card

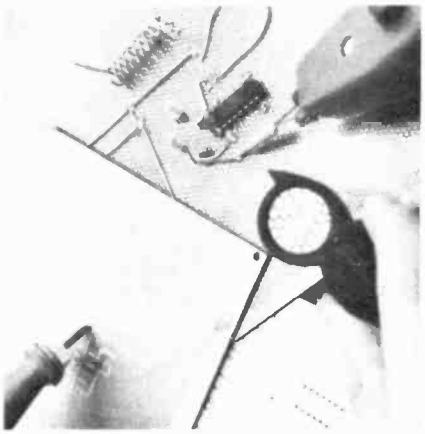
HOME ALARM SETS, *Snap On.* Every component is pre-wired with exclusive *Snap On*

connectors. There are no wires to cut, strip, solder or splice. Power source is a standard 6- or 12-volt battery.

Each set includes a solid-state control center that is always alert to fire danger, even when the burglary system is turned off; an electronic siren with separate signals for fire or burglary; a key switch that permits the system to be turned on or off from outside the home; intrusion detectors for doors or windows; fire detectors; 20-foot extension cords; three-way connectors; an easy-to-follow installation manual; identifying warning decals. $69.95; expanded deluxe version $99.50.—**Master Lock Co.,** 2600 North 32nd Street, Milwaukee, WI 53210.

Circle 44 on reader service card

NON-CONDUCTING METAL SHEET for printed circuitry. To make a simple circuit or a complex multi-layer breadboard, you draw or scribe your design directly on the surface of the material which instantly ren-

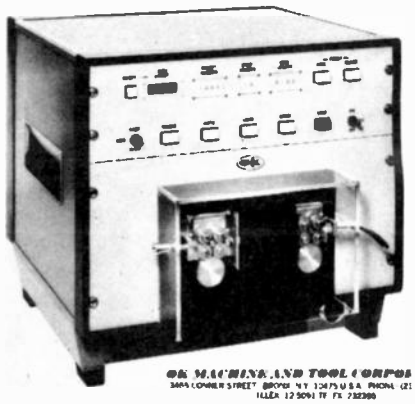


ders a working circuit. Pressure is all that is necessary. For mass production, a letter press can be used. Without using a new board, circuits can be erased for making new designs. Since the metal sheet is non-conducting, components and wiring can be spot-soldered at random, independent from adjacent areas of the board. For use in solid-

state printed circuitry, breadboarding, terminal blocks, chassis, etc.—**Metal Circuit Systems Corp.**, P.O. Drawer 2226, Houston, TX 77001.

Circle 45 on reader service card

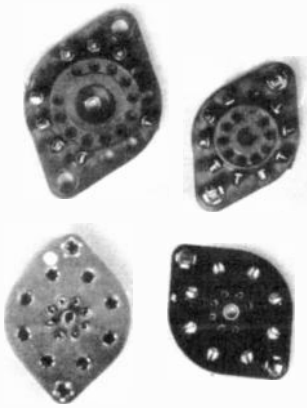
WIRE STRIPPER, *model EWS-10K.* Cuts and strips 5000 wires per hour with 6 in. wire length. Strip length from 0-1.5 inches in 0.1 inch steps; wire length from 2.5-99.9 inches in 0.1 inch steps. Wire feeds via two stepping motors; wire length and strip length controlled by gating proper number of motor



steps. Same strip block used for all lengths. All solid-state control; no air required. Preset number stops operation automatically after selected number of cycles. Non-nicking blades are made of heat treated tool steel. Complete panel functions; three operating speeds—slow, medium, fast. For AWG24-30. 18 × 20 × 20 in.; 90 lbs.—**OK Machine and Tool Corp.**, 3455 Conner Street, Bronx, NY 10475.

Circle 46 on reader service card

EXACT REPLACEMENT ZENITH SOCKETS, *Kit No. 39* contains a general purpose assortment of four sockets, none of which has a substitute. In addition to this kit, Oneida



also offers zenith sockets S-74-C, an exact 9-pin replacement and S-75-C, an exact 12-pin replacement. Combination of the kit assortment plus the other two sockets provides complete Zenith coverage.—**Oneida,** Box 558, Meadville, PA 16335. **R-E**

Circle 47 on reader service card

American Airlines installs TV on all its luxury planes

Special television systems that provide recorded TV shows or full-length movies have been installed on all of American's DC-10 Luxury Liners. Each DC-10 is equipped with a color video-cassette player/recorder in the first class section and a 25-inch RCA XL-100 television set in the cabin. **R-E**

new lit

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

ELECTRONIC COMPONENTS CATALOG. 35-page catalog contains 350 items carrying the Ultratec label. Among them are mike, tape and phono accessories, miscellaneous electronic accessories, audio cables and adapters, hi-fi and hobby electronics, tools and service aids, panel lamps, fuses and battery holders, wires and cables and electronic construction components. An alpha/numerical index appears at the end of the catalog. —**Workman Electronic Products, Inc.,** Box 3828, Sarasota, FL 33578.

Circle 48 on reader service card

J-JACKS CATALOG. 12-page brochure explains the company's J-Jacks system for educational and medical TV systems; permits distribution of uhf, vhf, FM, closed-circuit video and audio signals simultaneously throughout the school or hospital; also has 2-way signal carrying capability. Covers design and installation, from basic distribution systems to sophisticated automatic 2-way systems. Architect specifications are also included.—**Jerrold Electronics Corp.,** 401 Walnut Street, Philadelphia, PA 19105.

Circle 49 on reader service card

KIT CATALOG. 56-page catalog lists over 175 different kits ranging in price from a few dollars to a few hundred dollars. Product areas covered are amplifiers and preamplifiers, test instruments, power supplies, radio control apparatus, auto accessories, ham and CB accessories, musical instrument accessories, FM transmitters and receivers. Many illustrations.—**Audiex Electronics,** P.O. Box 156, Station "S", Toronto, Ontario, Canada M5M 4L7.

Circle 50 on reader service card

BUSINESS FORMS CATALOG. 32-page catalog for television and appliance firms contains multipart service order forms, repair tags, sales forms and billing forms. These forms are in duplicate and triplicate sets, consecutively numbered and imprinted with your firm's name and address. Also featured are business cards, pressure sensitive labels, carbonless register forms, bookkeeping systems and many other business forms. Illustrations in color.—**New England Business Service, Inc.,** P.O. Box 500, Townsend, MA 01469.

Circle 51 on reader service card

CHART, *Increase Your Viewing Pleasure.* Complete buyers' and sellers' guide to RCA Permacolor outdoor antennas, uhf-vhf/FM, vhf/FM, uhf-only, FM-only; rotators (including Selecta-channel 10W606); three different types of antenna mounting kits and Mini-State antenna system with hand-held rotator remote control unit. 11 x 44 in.; shows inside components of Mini-State antenna and cabinet design of rotators; also lists components of antenna mounting kits that are available.—**RCA Parts and Accessories,** P.O. Box 100, Deptford, NJ 08096.

Circle 52 on reader service card

HI-FI LOUDSPEAKER SYSTEMS CATALOG. 24-page illustrated brochure describes floor standing loudspeaker systems, compact loudspeaker systems, Stonehenge I and III loudspeaker systems as well as components and utility systems. Price list is inserted in brochure.—**Altec Sound Products Division,** 1515 South Manchester, Anaheim, CA 92803.

Circle 53 on reader service card

1974-75 VHF-UHF-FM TUNER REPLACEMENT GUIDE AND PARTS CATALOG NO. 4. 95-page catalog contains exact tuner replacements, widely used tuner parts, chemicals and tools. Indexes for blow-ups and uhf tuners. Covers Standard Kollsman, Oak, Sarkes Tarzian, RCA, Zenith, Philco, Motorola, G.I., miscellaneous, domestic and foreign made tuners. Includes antenna matching coils and antenna coil replacement guide. $2.00; refundable on first order for goods or services.—**PTS Electronics, Inc.,** P.O. Box 272, 5322 Hwy. 37 S., Bloomington, IN 47401.

STEREO & 4-CHANNEL CATALOG. 32-page catalog contains 8-track stereo recording decks, AM/FM stereo systems, turntables, mini changers, TV tuner and electronic control cleaner, speaker systems, recording tapes, hi-fi shelving unit, tape recorded control center, headphones, audio gadgets and many illustrations.—**Etco Electronics,** Box 741, Montreal, Quebec, Canada. **R-E**

COSMOS PROJECTS

(continued from page 60)

voltage swing of C1 is clamped to the limits of the power supply voltage by the input protection diodes of the COS/MOS gates, the operating frequency is influenced by variations in the supply voltage: Typically, a 40% variation in supply vol-

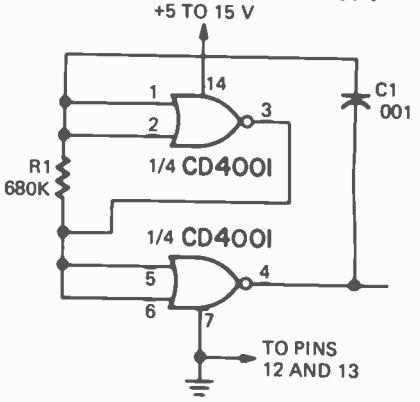
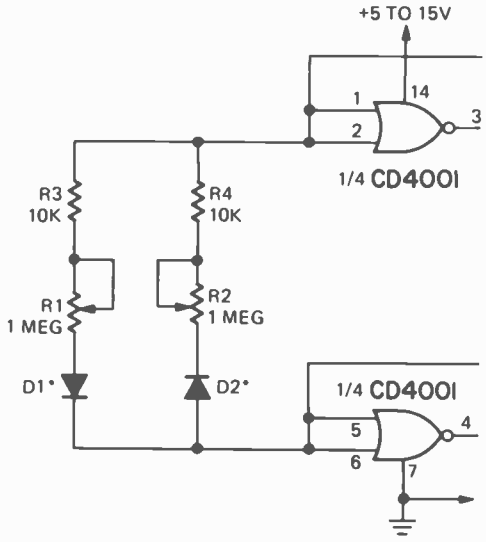
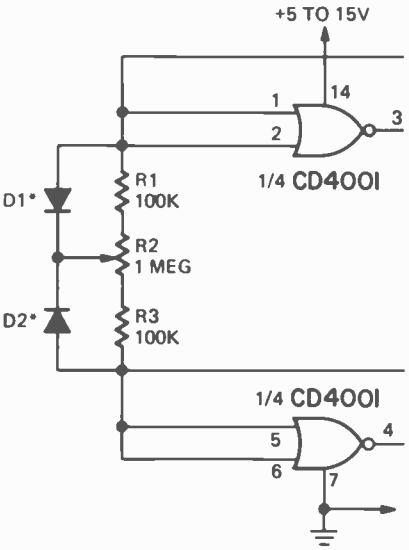


FIG. 30—BUFFERED-OUTPUT 1-KHZ astable



*D1 AND D2 = LOW-LEAKAGE GENERAL-

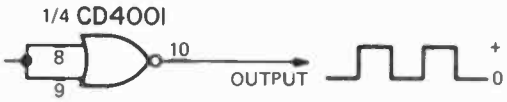


*D1 AND D2 = LOW-LEAKAGE GENERAL-

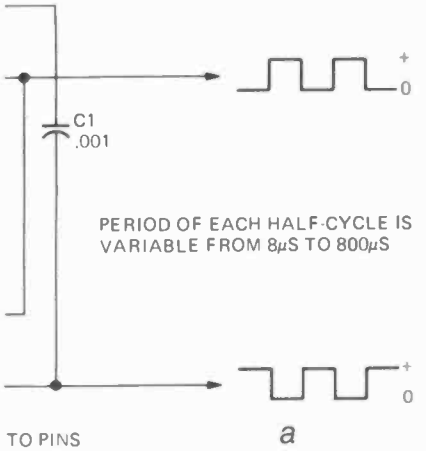
FIG. 31-a—VARIABLE MARK/SPACE RATIO VIBRATOR with independently variable on

tage causes a 5% variation in frequency. Another disadvantage is that the frequency of operation is influenced by the transition voltage values of the CD4001 gates and in practice, the actual frequency of operation may vary by 10% over the production spread of the CD-4001 when using identical R1 and C1 values.

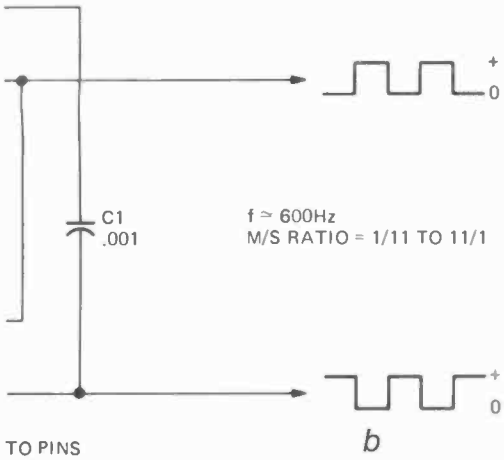
(continued on page 90)



multivibrator.



PURPOSE SILICON DIODES



PURPOSE SILICON DIODES

astable multivibrator. b—ASTABLE MULTI- and off times.

(continued on page 89)

Both of these disadavantages can be largely overcome by simply wiring a high value resistor in series with the input of gate A, as shown in Fig. 29, thus enabling the voltage swing of C1 to exceed the supply voltage. Limiting resistor R2 must have a value at least double that of timing resistor R1.

In practice, the operating frequency of this circuit is subject to a change of less than 5% over the production spread of transfer voltages, and to a frequency shift of less than 2% with a 40% change in supply voltage. Another advantage conferred by the use of R2 in the Fig. 29 circuit is that of excellent thermal stability: The operating frequency typically varies by only 1% over the temperature range –40°C to +85°C.

Minor disadvantages of both the Fig. 26 and Fig. 29 circuits are that the leading and trailing edges of the output waveforms sometimes contain a certain amount of sag and 'mush', and the operating frequency is influenced by variations in the output loading conditions. Both of these disadvantages can be overcome by interposing an inverting buffer stage between the output of the astable multivibrator and the input of the external loading circuit, as shown in Fig. 30.

A final disadvantage of the Fig. 26 circuit, and to a lesser degree of the Fig. 29 circuit, is that the symmetry or mark/space ratio of the output waveform depends on the transition voltage value of the individual CD4001 that is used. An IC with a transition voltage value of 35% gives a mark/space ratio of approximately 35/65, and an IC with a value of 60% gives a mark/space ratio of approximately 60/40. A true square wave (50/50) output is available only if the IC has a transition voltage value of exactly 50%.

The mark/space ratio of the output waveform of the astable circuit can be made variable by using steering diodes to select alternative charge and recharge resistance paths for the time-constant network, as shown in Figs. 31-a and 31-b.

In the Fig. 31-a circuit, the capacitor charges via D1 and the low half of the resistance chain in one half cycle, and via D2 and the top half of the resistance chain in the other half cycle. The mark/space ratio can be varied over the range 1/11 to 11/1 via R2, and the circuit operates at a frequency of roughly 600 Hz.

The Fig. 31-b circuit has independently variable ON and OFF times. In one half cycle, the capacitor charges via D1—R1 and R3, and in the other half cycle, it charges via D2—R2 and R4. The period of each half cycle is variable over the approximate range 8 μs to 800 μs using the component values shown.

In this part of the series we have looked at practical ways of using the CD4001 in monostable and astable multivibrator applications. In the coming part of the series we shall go on to look at sixteen ways of using the CD4001 in lamp flasher, time delay, oscillator, and alarm applications. **R-E**

key sends a pulse to the 2-bit page counter which increases its count by 1 and advances the page controls 1 step.

In AUTO, the page will automatically change every time a character is entered into the last position in a page. The instant after the page change, the new page's home position is at the cursor position. The black "P" key can still be used to change pages in the AUTO mode.

In the AUTO STOP mode, the operation is identical except that the automatic page change can be stopped on any page desired by wiring from the PAGE switch to one of four points. This gives the operator the advantage of being able to receive data into memory in the automatic mode and retain it, say, in the first 3 pages, and work on the 4th page without writing over it, and not having to change any switches.

In either automatic mode, pressing the clear key (black "C") will have the same effect as entering data into memory in the last position. This results in a page change every time you clear a page in automatic. This gives the operator the advantage of clearing all 4 pages with 4 key strokes of the clear key.

Power supply

The power supply consists of two paralleled power transformers (for added current and packaging requirements), a +250 volt unregulated supply, two +5 volt regulated supplies, a −10 volt an −12 volt Zener regulated supply.

The +250 volt supply runs the self scan plasma display. One of the +5 volt supplies runs all logic on the main board, and the other runs the keyboard, modem/coupler board, and add on memory board. The −10 volt supply powers only the memory, while the −12 volt supply is connected to the UART and to the modem/coupler board to power the op-amp and XR210 demodulator.

Tape recorder memory

Using the tape record feature to record and play tapes from the CT-256, a medium quality (cost greater than $50) or better cassette recorder is advisable along with a good quality recording tape. Of course a good reel to reel machine would insure better data integrity but good results are obtainable from a cassette machine.

Making a recording is as simple as connecting a miniature phone plug to the jack on the back of the CT-256 and the other end to the "mic." input on your tape recorder. Once you have

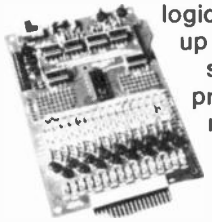
(continued on page 106)

There's a new Heathkit everyone on

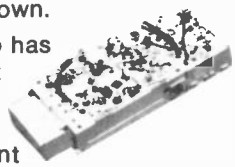
The Heathkit Digital Color TV is for two kinds of people

... those who understand electronics, and those who don't

People who understand electronics will appreciate the GR-2000's advanced digital design, incorporating on-screen channel readout and optional clock. Digital logic circuitry programs up to 16 stations in any sequence. Then just press a button—you'll never have to switch through a "dead" channel again. And our exclusive VHF/UHF varactor tuner eliminates clunking contacts that corrode and noisy motors that break down.



The GR-2000 also has the industry's first fixed-filter IF amplifier. There's no need for instrument IF alignment ever, so the picture stays bright and clear year after year. And even in urban areas where stations are packed closely together, there's virtually no adjacent channel interference.



The 100% solid-state chassis uses 19 integrated circuits—more than any other TV around. You'll get superior performance and reliability no conventional set can match.

A built-in dot generator and test meter make it easy to keep the GR-2000 in peak condition without expensive service calls. The slide-out service drawer and hinged, swing-out chassis put everything in easy reach. If anything ever goes wrong, an extensive trouble-shooting guide will help you fix it.

And people who don't understand electronics will enjoy the best looking picture around. *Popular Electronics* said the picture on the 25" (diagonal) screen "can only be described as superb. The Black (Negative) Matrix CRT, the tuner and IF strip, and the video amplifier provide a picture equal to that of many studio monitors..."

Everyone likes the on-screen readout that puts the channel number into the picture whenever you want it. When you change channels or touch the recall button, the big, bright digits reappear. Add the optional clock module and you'll see the time as well as the channel.

The optional wireless remote control makes the GR-2000 even more enjoyable. Change channels, adjust the volume, set tint and color intensity and turn the set on or off from across the room. And, a touch of the Volume bar automatically returns the digital readout to the screen momentarily. It's an amazing handful of convenience.

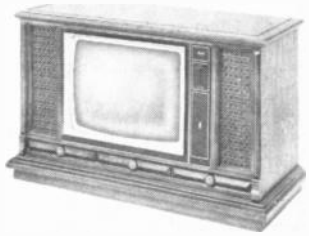
Even if you don't have a lot of kit-building experience, you'll enjoy the GR-2000. Illustrated step-by-step instructions, prefabricated wiring harnesses, transistor and IC sockets and modular circuit boards greatly simplify assembly.

See the TV the experts are talking about. *Popular Electronics* summed it all up: "In our view, the color TV of the future is here—and Heath's GR-2000 is it!"

GR-2000—the TV everyone can appreciate.

Mail order price for chassis and tube, $669.95. Remote control, $89.95, mail order.

Cabinets start at $154.95, mail order. (Retail prices slightly higher.)



Christmas gift for your list

Our new Heathkit Desktop Electronic Sliderule Solves Your Gift-Giving Problems

Give your scientist, engineer or student a gift he'll use all year long. Finger-sized keys and 8 bright ½" digits make it easier to use than pocket calculators. Cumulative memory and register exchanges virtually eliminate scratchpad work. Performs arithmetic plus trig and arc trig in degrees or radians, common and natural logs,

powers of e, square roots, inverses, pi and exponential functions. **Kit IC-2100,** 4 lbs., mailable . . **119.95***

New Heathkit Electronic Clock/Timer for Car, Boat or Plane

A timely gift—

an electronic clock and a 20-hour rally timer, both with quartz crystal accuracy. Bright ½"-tall digits dim automatically at night. 12 VDC, mounts on or under dash. **Kit GC-1093,** 2 lbs., mailable **62.95***

Two Heathkit Electronic Clocks with Standby Power

Two beautiful gifts—the GC-1092A is a clock with a snooze alarm; the GC-1092D reads the time in 6 digits, the month and date in 4 digits. Both have standby power to keep the clock on time without the display even during temporary power interruptions. (Batteries not included.) **Kit GC-1092A or D,** 5 lbs., mailable . . . . . **each 82.95***

Time/Alarm

Time/Date

Unique New Heathkit AM/FM Digital Clock Radio

Our outstanding clock radio makes even sleepy Santas happy.

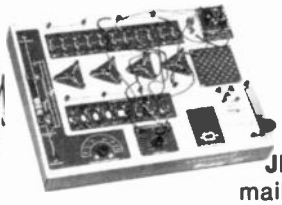
The electronic clock with snooze alarm features a gentle "beep" with adjustable volume. Or wake to the component-quality AM/FM radio. Standby batteries (not included) keep the clock on time during power interruptions. **Kit GR-1075,** 10 lbs., mailable **129.95***

New Heathkit Aircraft Strobe

A bright idea for the pilot on your list—or for anyone who needs an emergency marine or marker light. It meets FAR 23.1401 and assembles easily in just one evening. For 12 VDC neg. ground. With clear lens, optional red and red/clear lenses available. **Kit OL-1155,** 3 lbs., mailable **54.95***

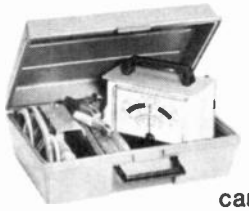
Learning's Fun With Our New Heathkit "Electronics Workshop"

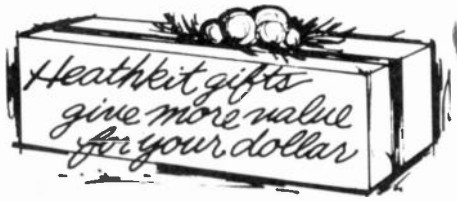
The JK-18A teaches kids electronics the easy learn-by-doing way. 35 exciting projects include light meter, sound meter, transistor radios. For safety, it's battery powered and requires no soldering. (Batteries not included) **Kit JK-18A,** 10 lbs., mailable . . **34.95***



Heathkit Exhaust Analyzer Checks Your Car's Tune Up

Make everyone's Christmas whiter and cleaner—be sure your tune up is helping clean up the environment. Big 4½" meter reads relative combustion efficiency, air-fuel ratio and percentage carbon monoxide. **Kit CI-1080,** 6 lbs., mailable . . . **59.95***





Circle 100 on reader service card

Exciting new Heathkit Christmas giving

new Heathkit dual-trace DC-15MHz scope

Compare the features:

- Dual-trace with true X-Y capability
- 1 mV/cm vertical sensitivity over the full bandwidth
- Post-deflection accelerated CRT for bright trace, fast writing
- Vertical amplifier delay lines for pulse analysis capability
- Digitally controlled triggering for exceptional stability
  - Typically triggers up to 45 MHz—guaranteed to 30 MHz

It offers a lot more than just a low price

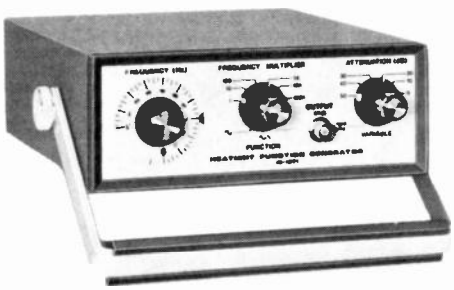
The Heathkit IO-4510 is your best 'scope buy for two good reasons—it does more and it costs less.

Time base sweep up to 100 nsec/cm. There's always a reference baseline, even when there's no trigger signal. The time base can be precisely triggered at any point along the positive or negative slope of the trigger signal. In automatic mode, it triggers at the zero crossing point.

Modes of display. Either channel can be displayed as a function of time or both can be displayed together. In X-Y operation, channel 1 provides horizontal deflection and channel 2 provides vertical deflection. There are 22 calibrated time bases from 0.2 sec/cm to 0.1 μsec/cm. The sweep speed is continuously variable between switch positions. Any speed can be expanded five times by pulling out the control knob.

For easy calibration, a 1 volt peak-to-peak square wave is available on the front panel. The regulated supply operates from 100-280-volt AC power. **Kit IO-4510,** 34 lbs., mailable **549.95***

Assembled SO-4510, factory-wired & calibrated version of the IO-4510, 34 lbs., mailable **750.00***



New Low-Cost Heathkit Function Generator

A true function generator, not an oscillator, delivers sine, square and triangle waveforms from 0.1 Hz to 1 MHz. Short-proof output supplies 10 volts peak-to-peak into 50-ohm load. A calibrated step attenuator adjusts from 0-50 dB (10V to 30 mV) in 10 dB steps. A variable control provides up to 20 dB of additional attenuation at each step. Attenuator accuracy is ±1 dB; frequency accuracy is ±3%. Nonlinearity of the triangle waveform is 5% max., symmetry is within 10%. Sine wave THD is 3% max. from 5-100k Hz. Square wave rise and fall times are 100 nsec max. 105-130 or 210-260 VAC. **Kit IG-1271,** 7 lbs., mailable **99.95***

Assembled SG-1271, factory-wired & calibrated version of IG-1271, 7 lbs., mailable **140.00***

projects-timed for

Coming in December...

A new generation of Heathkit ham radio equipment

New Heathkit SB-104 transceiver

Years ahead in design & features — the SB-104 is a complete rethinking of what a CW/SSB transceiver should be. It utilizes the latest digital & solid-state technologies. The "104" is completely solid-state from the front end to the RF output.

Totally broadbanded. You can switch from 3 to 30 MHz without preselector, load or tune controls.

True digital readout with 6 bright digits to indicate the frequency with accuracy to 100 Hz.

Mobile-ready. The SB-104 operates from 12 VDC, so it's ready to go mobile when you are. Optional features include a plug-in digital noise blanker and 400 Hz crystal filter for CW.

Just about the only things that aren't totally new about the "104" are the quality and easy assembly that have made Heath famous. **Kit SB-104,** 31 lbs., mailable 669.95*

Kit SBA-104-3, 400 Hz CW crystal filter for SB-104, 1 lb., mailable 34.95

Kit SBA-104-1, digital noise blanker for SB-104, 1 lb., mailable 24.95*

Kit SBA-104-2, mobile mount, 6 lbs., mailable 34.95*

New Heathkit SB-230 1 kW conduction-cooled linear

High-power match for the SB-104. Lowest cost conduction cooled linear on the market. 1200 watts PEP and 1000 watts CW from less than 100 watts input. It's also rated at 400 watts input for slow-scan TV and RTTY. And absolutely silent — no blowers, no fans.

Full metering of relative power, plate current, grid current and plate high voltage. Safety features include microswitch interlocks for top and bottom shells, thermal shutdown, fused cathode, on/off switch with circuit breaker for power transformer.

On the air in 15 to 20 hours. Fast, easy assembly, then check it out with an ohmmeter — no alignment necessary. **Kit SB-230,** 40 lbs., mailable 319.95*

New Heathkit SB-614 station monitor scope

How clean is your signal? The bright 1½ x 2" screen helps you keep your rig in peak condition. Reveals a wide variety of operating problems — nonlinearity, insufficient or excessive drive, carrier or sideband suppression problems, regeneration and key clicks. Monitors AM, SSB and CW signals up to 1 kW from 80 to 6 meters. **Kit SB-614,** 17 lbs., mailable.....139.95*

New Heathkit 5-Function SB-634 station console

Five accessories in one — a 24-hour 6-digit electronic clock, a ten-minute digital ID timer with visual and/or audible alarms, RF wattmeter, SWR bridge, hybrid phone patch with manual and VOX controls. **Kit SB-634,** 14 lbs., mailable 179.95*

New Heathkit SB-644 remote VFO

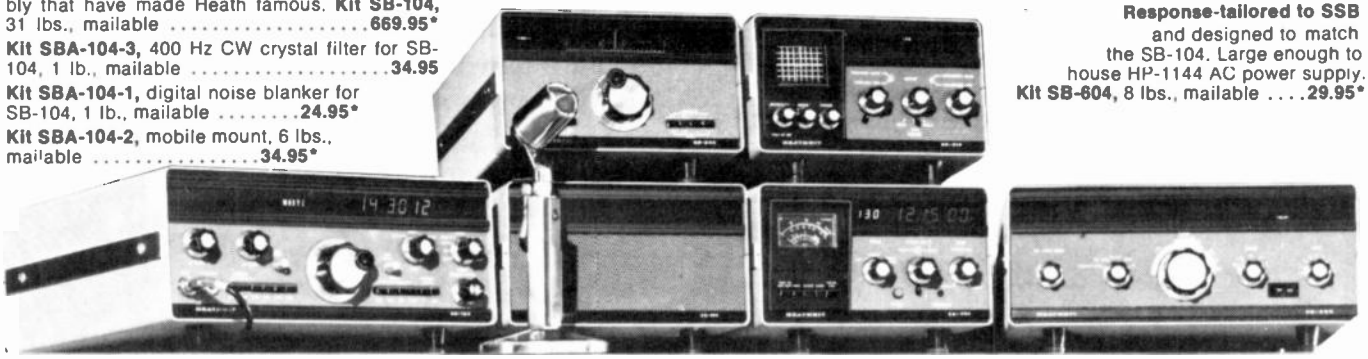
Designed exclusive for SB-104, it provides the ultimate in multi-mode operation with two crystal sockets for fixed frequencies. No modifications — just plug the VFO into the "104" and go — VFO frequency even reads out on the 104's digital display. **Kit SB-644,** 10 lbs., mailable 119.95*

New Heathkit Fixed station AC power supply

Powers the SB-104 from 120 or 240 VAC. Sophisticated regulation assures almost no change in voltage from no load to full load. Entire supply fits inside SB-604 speaker cabinet. **Kit HP-1144,** 28 lbs., mailable 89.95*

New Heathkit SB-604 station speaker

Response-tailored to SSB and designed to match the SB-104. Large enough to house HP-1144 AC power supply. **Kit SB-604,** 8 lbs., mailable 29.95*



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- ☐ GRA-2000-6 TV remote control
- ☐ IC-2100 Calculator
- ☐ CI-1080 Exhaust analyzer
- ☐ GR-1075 Digital clock radio
- ☐ GC-1093 Digital car clock/timer
- ☐ JK-18A Junior electronics workshop
- ☐ GC-1092A Digital clock with snooze alarm
- ☐ GC-1092D Digital clock with date display
- ☐ IO-4510 Osc lloscope (kit)
- ☐ SO-4510 Oscilloscope (assembled)
- ☐ IG-1271 Function generator (kit)
- ☐ SG-1271 Function generator (assembled)
- ☐ SB-104 Transceiver
- ☐ SB-104-1 Noise blanker
- ☐ SB-104-2 Mobile mount
- ☐ SB-104-3 CW crystal filter
- ☐ SB-230 1 kW linear
- ☐ SB-614 Monitor scope
- ☐ SB-634 Station monitor
- ☐ SB-644 Remote VFO
- ☐ HP-1144 AC power supply
- ☐ SB-604 Station speaker

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Circle 100 on reader service card

next month

DECEMBER 1974

■ **New 1975 color TV circuits**
The new sets have arrived and with them come some fascinating circuits. We've selected several of the more interesting ones and describe them here.

■ **Digital Remote Control For TV**
Punch out the channel on a calculator-type keyboard. The set switches and the channel number appears on the screen. See how it works.

■ **Build DVM Plug-In For Grinchwall**
Add-on plug-in multimeter makes your Grinchwall digital instrument more useful than ever.

■ **All About MOS Shift Registers**
Learn how these special IC's work and how you can use them effectively.

PLUS
Step-By-Step Troubleshooting Charts
Equipment Reports
Appliance Clinic
Jack Darr's Service Clinic

December issue goes on sale November 18, 1974

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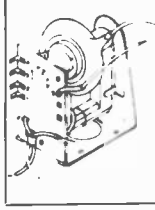

We scooped the Market. Latest type — standard for all 110° TV's
RCA's design of large Coil produces 18KV—assuring adequate width Incl. Schematic Diagram application for any TV.
List price $13.90 **3.95**
Your price .....
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Leaves messages for other for replay . . . Built in speaker/microphone for talk-into convenience . . . Records up to 3 minutes of messages . . . Illuminated signal shows when a message is waiting. Control adjusts playback volume without affecting recording volume . . . Capstan Drive: **7.95**
BRAND NEW SOLD AS IS

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7"	— 1800'..... 1.32	3" TAPE REEL	.09
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Latest Compact Model good for all 41 mc TV's. BRAND NEW —

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

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Circle 79 on reader service card

BUILD—with 1 IC 3-way function generator

Build this precision instrument for less than $11. Add your own case and power supply and you've got a quality compact generator

By ROBERT COLMAN

A LARGE NUMBER OF *Radio-Electronics* READERS OWN elaborate and costly high-quality, high-fidelity sound systems. To check the performance of sound systems of this type requires the use of sophisticated high-performance signal generators. Unfortunately, such instruments are usually very costly and would not be used often enough to justify their purchase.

But there is an alternative. It is a 14-pin monolithic integrated circuit which can deliver sine, square, triangle and pulse waveforms that are highly accurate. This new IC is the Intersil 8038. It operates over a frequency range from .001 Hz to 1 MHz and is highly stable over a wide range of temperature and supply voltages. By using additional external voltages, it is even possible to use the IC as a sweep generator and add FM modulation. The device uses the latest technology, including thin-film resistors and Schottky-barrier layer diodes.

Although the more complex functions of the 8038 are certain to interest some readers, we were primarily interested in the design of a basic audio signal generator that would deliver signals from 20 Hz to 20 kHz using only a single tuning control. The output signals produced by the generator are square, triangle and sine waves.

How the circuit works

A block diagram of the 8038 IC function generator is shown in Figure 1. The external timing capacitor C1 is alternately charged and discharged by two current sources.

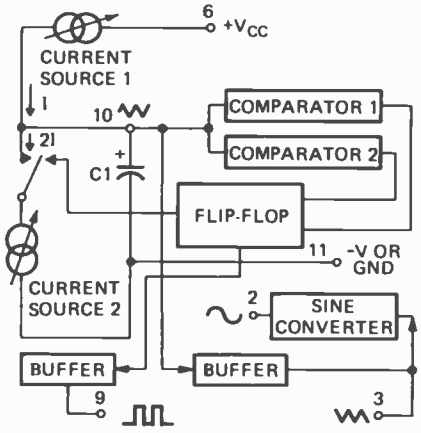
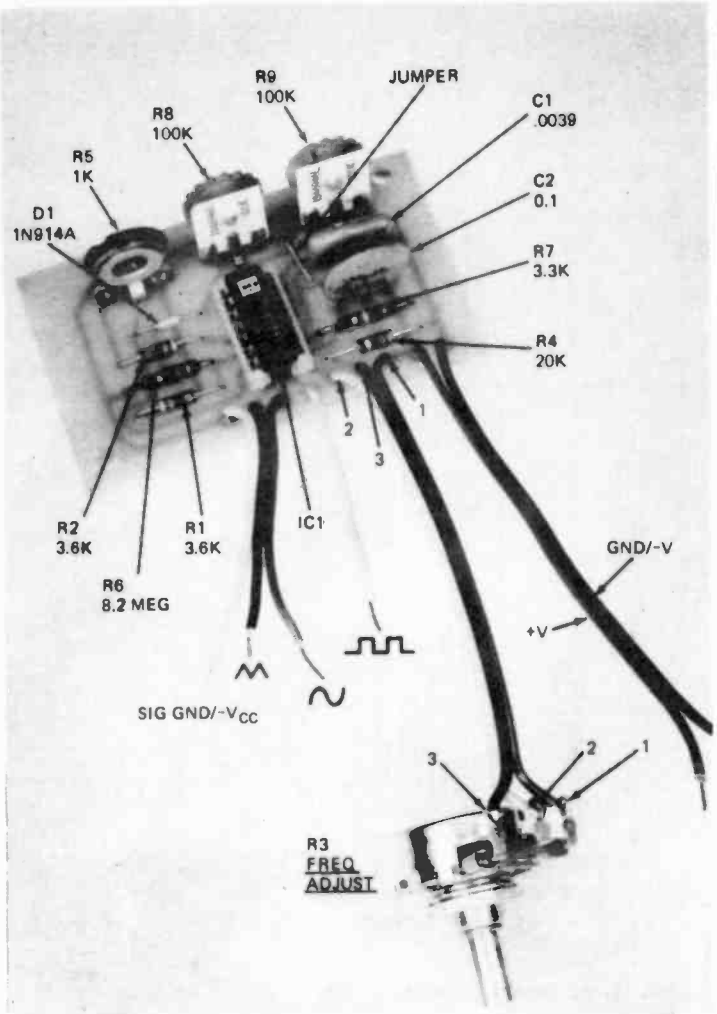


FIG. 1 — BLOCK diagram of waveform generator. All elements, except for C1, are in the IC.



CALLOUTS IN PHOTO of completed generator show where to mount parts on the circuit board.

Current source 1 is on at all times while current source 2 is switched on and off by a flip-flop.

Assuming that, initially, the flip-flop turns off current source 2, the capacitor is charged by current source 1 with a current I. As a result, the voltage across the capacitor rises linearly with time. When the voltage across the capacitor reaches the threshold voltage of comparator 1 (which is set at $\frac{2}{3}$ of the supply voltage), the flip-flop changes state and turns on current source 2 which carries a current of 2I. The capacitor is discharged with a net current I and the voltage across it drops linearly with time. As the capacitor discharges toward a negative peak, it eventually reaches the threshold voltage of comparator 2 (set at $\frac{1}{3}$ of the supply voltage). When this occurs, the comparator output resets the flip-flop to its original state and current source 2 is turned off. At this point, the cycle is repeated.

The triangular waveform, which is developed across the timing capacitor, is fed internally to a buffer amplifier and is available for external use at the output pin 3. In addition, the triangle waveform is fed to a sine converter, which consists of a non-linear network, for conversion to a sinusoidal waveform. According to Intersil, the typical total harmonic distortion of the sine wave output is less than 1%. With careful adjustment, distortion levels as low as 0.5% are possible.

The square wave output is taken from the flip-flop and fed to another buffer amplifier, the collector of which is connected to output pin 9. In this manner, the supply voltage for the square wave output is independent of the rest of the circuitry and a separate 5 V supply may be used to provide TTL compatibility.

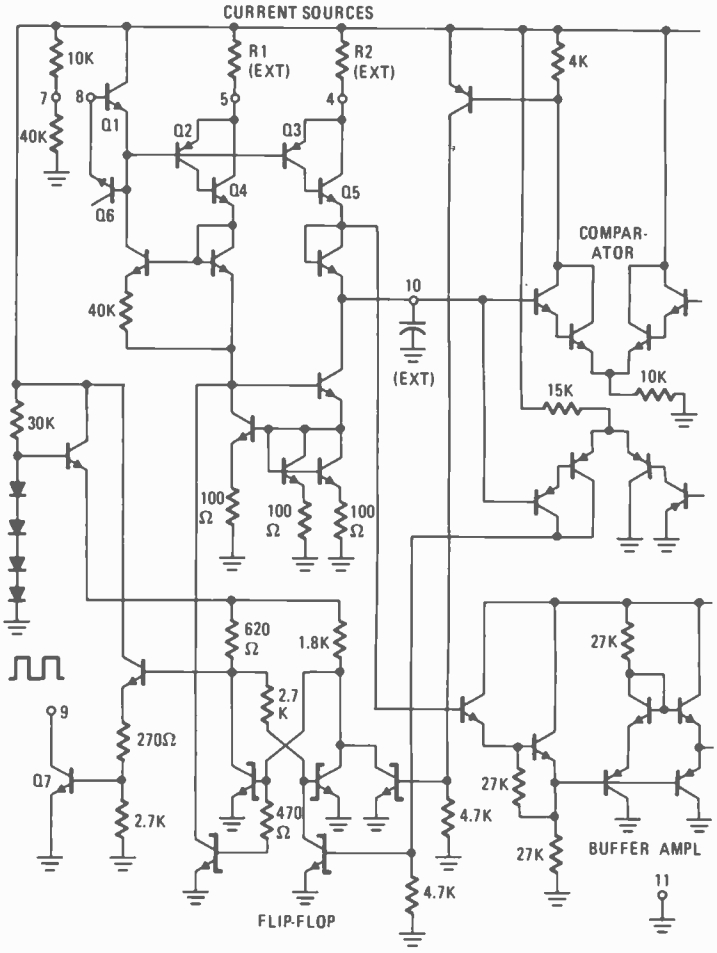


FIG. 2—DETAILED CIRCUIT DIAGRAM of the Intersil 8038 IC waveform generator.

Design

Since we propose to sweep the frequency of the generator over a 1000:1 range, let's take a look at what determines the output frequency. Figure 2 shows the detailed circuit diagram of the 8038 IC waveform generator.

The voltage developed across the two external resistors, R1 and R2, produces two currents to charge and discharge the timing capacitor tied to pin 10. Because this is a linear system, dropping the voltage across the external resistors from 10 volts to 1 volt will also drop the lower output frequency by a factor of 10. This will increase the output frequency range by 10:1. Lowering the voltage still further from 1 volt to 100 mV will also increase the output frequency range by another 10:1. By causing the voltage across the external resistors to change, say from 10 V to 10 mV, we can vary the output frequency at least 1000:1.

Transistors Q2 and Q3 supply the charging current to the external capacitor. This current is determined by the value of resistors R1 and R2, as well as the bias current of

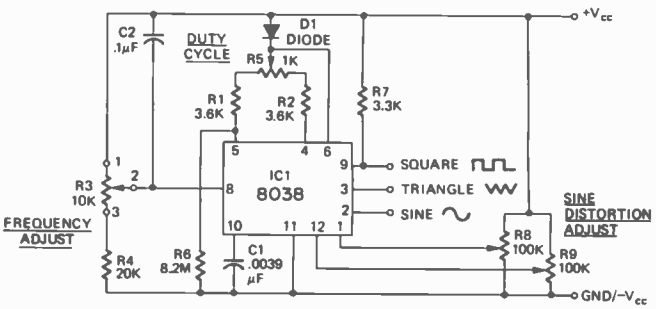
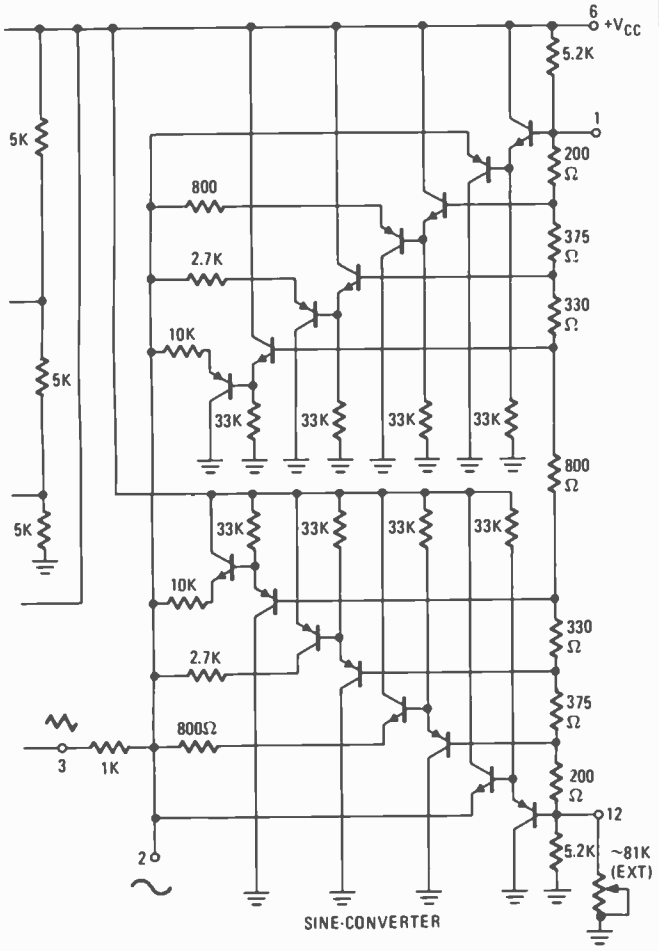


FIG. 3—SCHEMATIC OF THE GENERATOR. Circuit is built around the Intersil 8038 waveform generator IC.



PARTS LIST

R1, R2—3,600 ohms, ¼W, 10%
R3—pot, 10,000 ohms, linear taper
R4—20,000 ohms, ¼W, 10%
R5—1,000 ohms, trimmer resistor
R6—8,200,000 ohms, ¼W, 10%
R7—3,300 ohms, ¼W, 10%
R8, R9—100,000 ohms, trimmer resistor
C1—.0039-μF Mylar
C2—.1-μF 25Vdc disc
D1—1N914A silicon diode
IC1—Intersil 8038CC waveform generator
Power source, case, PC board, wire, solder, hardware.

The following parts are available from
Photolume Corporation
118 East 28th Street
New York, N.Y. 10016

Parts Kit, NOT including case and power supply — $10.95 incl. postage and insurance.
Circuit board—$2.50.

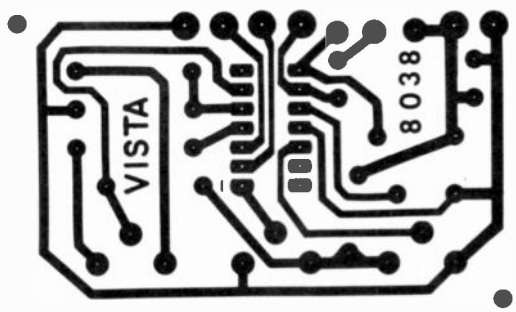


FIG.4—FULL-SIZE FOIL PATTERN of the circuit board for the generator.

transistor Q1. Due to the V_{be} mismatch between transistors Q1 and Q2 (also Q1 and Q3) and because of the circuit geometries and current levels involved, the voltage across the external resistors R1 and R2, with pin 8 connected directly to $+V_{cc}$, will be 100 mV or more, with a 100:1 sweep ratio. To obtain the smaller voltages necessary for the required 1000:1 frequency range, the voltage at pin 8 must be raised above $+V_{cc}$. The required voltage difference need only be a few hundred millivolts, which we can get without a separate power supply by simply adding a series diode from pin 6 to the external resistors R1 and R2 (see Fig. 3). This raises the applied voltage to pin 8 by one diode drop above $+V_{cc}$.

The charging current carried by transistors Q2 and Q3 is determined by the impedance between pins 4 and 5, as well as the bias currents. Any small offset or differential voltage will cause an imbalance in the charge and discharge currents and a marked change in the duty cycle. While a single external resistor is fine for simple circuits, for our more demanding performance requirement, we use the separate external resistors R1 and R2. By using separate resistors, we can vary the ratio of the charge-to-discharge rate of the external capacitor. In this manner, the duty cycle of the square wave output signal is variable from 2% to 98% and the triangle output waveform can be adjusted for either a positive or negative going sawtooth or ramp.

To further lower the output distortion, the voltages applied to pins 1 and 12 are adjusted using two trim resistors (see Fig. 3). In addition, we can compensate for the remaining duty-cycle error by connecting a high value of resistance from pin 5 to $-V_{cc}$ which bleeds a small amount of current away from pin 5 and tends to bring the duty cycle back to 50%. With these basic adjustments, we have a reasonable compromise between low distortion and wide frequency range.

The schematic diagram of the actual generator circuit is shown in Fig. 3. The oscillator frequency of the 8038 IC is set by the value of timing capacitor C1 (.0039 μF) and the voltage applied to pin 8.

Construction

Construction of the actual audio function generator is easy. Only a few components are required in addition to the IC and power supply. Printed circuit construction is recommended and a foil pattern (Fig. 4) is supplied for the reader who wants to make his own. An etched and drilled circuit board is available (see parts list) for those who prefer to purchase one. While component tolerances are not critical, the use of a good quality Mylar film capacitor for C1 is recommended for stability of the output frequencies.

All the parts of the generator, with the exception of the FREQUENCY ADJUST potentiometer, are mounted on the circuit board. Parts layout is shown in the head photo.

Install and solder all resistors, capacitors and trimmer resistors on the PC board first. Solder the jumper in place on the foil side of the board. Next, install and solder diode. D1, being sure to observe the polarity.

Now install IC1 on the board. We recommend the use of an IC socket to prevent possible damage to the IC during soldering and to provide for easy replacement in case it malfunctions. The parts kit which is available (see parts list) includes an IC socket which consists of two MOLEX connectors and two plastic insulating jackets. Install the MOLEX connectors into the plastic jackets and solder the units to the PC board, being careful not to melt the plastic jackets with the heat from the soldering iron. After soldering, carefully break off the metal tab on each connector and install the IC.

The entire generator board with power supply or bat-

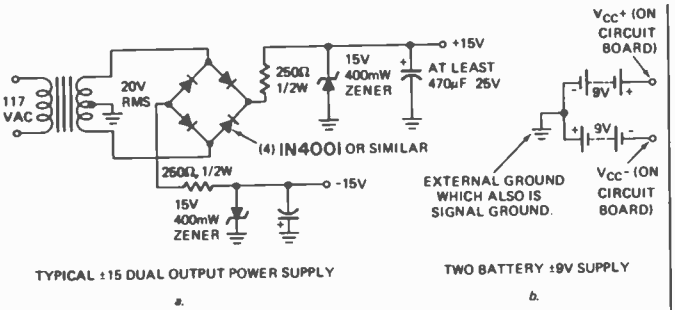


FIG. 5—POWER SUPPLY CIRCUITS. a—A Zener regulated supply. b—How batteries can be used.

teries and FREQUENCY ADJUST pot will fit into a case of the type readily available to readers. It will be necessary to obtain either output jacks or a terminal strip for the outputs.

Install the FREQUENCY ADJUST pot and output jacks on the case and solder leads to the appropriate points on the PC board. Install the PC board in the case, along with a source of power and a switch for turning it off and on.

Any simple power supply having reasonable regulation may be used. But be sure you do not exceed the manufacturer's recommended rating of ±15 Vdc or +30 Vdc of the 8038 IC. The circuit of a Zener regulated supply is shown in Fig. 5-a. Batteries can also be used, but they should be connected as shown in Fig. 5-b. Two 9-volt batteries should supply ample power, but keep in mind that the unit draws about 15 mA when selecting the batteries.

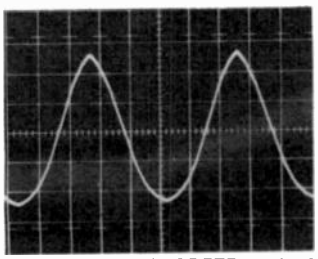


FIG. 6 — DISTORTED output waveform.

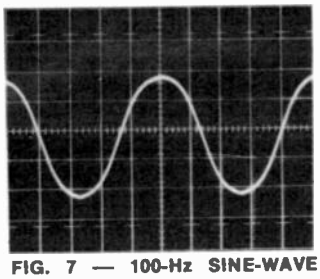


FIG. 7 — 100-Hz SINE-WAVE output.

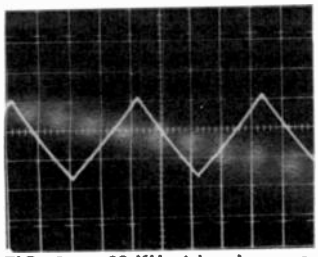


FIG. 8 — 20-KHz triangle wave output.

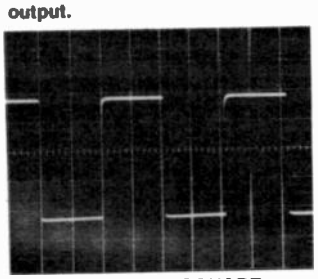


FIG. 9 — 20-KHz SQUARE wave output signal.

Adjustment

When assembly is completed and you are ready to put the function generator into operation, apply dc power to the unit.

To adjust for minimum distortion, connect your scope probe to the triangle waveform output and observe the symmetry of the waveform while adjusting the duty cycle trimmer R5. Adjust the sine-wave next by observing the waveform and alternately adjusting trimmer potentiometers R8 and R9 for minimum distortion. Figure 6 shows the distorted sine-wave when the trimmer pot is not adjusted correctly. If you have a distortion meter, you may use it as a final check on the setting of the sine-wave trimmers and adjusting them for minimum distortion. Check the square-wave output and readjust trimmer R5 if necessary for a 50% duty cycle. This completes the adjustments of the generator. The actual output waveforms are shown in Fig. 7, 8 and 9. R-E

COMPUTER TERMINAL

(continued from page 91)

connected to the computer and the phone is in the top of the terminal, you can set your audio level. If the recorder used has an automatic level control, use it; if not, record at a "0" dB level (maximum undistorted level).

To play a tape back, the MODE switch should be in the IN/OUT position and the playback level should be twice as high as to cause the CARRIER LED to light. Make sure the baud rate is set for the proper data rate on the recording. The connection to the CT-256 stays the same, just change the connection on the recorder from MIC. input to LINE out or EXT. SPEAKER.

Assembly

Building a one page CT 256 includes parts installation and wiring of 2 large double sided circuit boards, one medium and one small single sided board. For a multipage unit there is a third large double sided board containing up to three additional pages of memory plus power switching circuitry. First, parts are installed on all boards. (Be sure to follow handling instructions for MOS chips.) Switches and connectors are wired to the main board before its installation. Once the main board is installed in the chassis, the power supply board is wired in, the 5 volt regulators are installed and wired, and wiring to the acoustic coupler board completed (the kit comes with the acoustic coupler board assembled, tested, adjusted and installed in top cover of main case). Next, the switches, connectors and displays are mounted.

The keyboard assembly should be completed at this time, including assembly and wiring of keyboard connector and cable.

After a final wiring check and inspection for solder bridges, connect keyboard to main unit, connect self scan display to the main board, and set MODE switch to LOCAL. Connect to a 115 Vac power source and turn power switch to on. The page 1 LED should light, and characters should be entered from the keyboard. If problems arise, isolate the problems and analyze them using information from the text and diagrams. An oscilloscope is indispensable in trouble shooting this type of circuitry.

The following items are available from MITS, Micro-Instrumentation Telemetry Systems Inc., 6328 Linn, N.E., Albuquerque, NM 87108.

Complete kit of all parts $495.00
Kit less cabinet & power supply $395.00
Assembled Terminal $695.00

TABLE OF CONTROL CHARACTERS AND THEIR FUNCTION IN CT256

Control G—Bell signal—used to alert operator—a ½ second 1-kHz audible tone.

Control H—Backspace—moves data in display one position to the right—does not change data in memory.

Control I—Advance space—moves data in display one position to the left—does not change data in memory.

Control J—Control character for linefeed. Since it has no meaning in the CT-256 it is decoded and entered into memory as a space.

Control K—Home—homes memory address counters to cursor position.

Control L—Home and clear—homes memory address and clears page.

Control M—Control character for carriage return—has no meaning for the CT256. It is decoded and entered into memory as a space.

Control N—Control character for cursor up—has no meaning for the CT256 and is decoded and entered into memory as a space.

Control O—Address function—sets up receive circuitry to use the next two characters to shift data address to a selected line and position. (See explanation of address function.)

DEFINITIONS FOR SWITCHES AND CONNECTORS

CT256 KEYBOARD

Special Key Functions (Top Row of Black Keys)

[←] **Shift left**—Moves data left one position (advance).

[H] **Home**—Returns data to 0, 0 position.

[→] **Shift right**—Moves data right one position (backspace).

[A] **Address**—Three keystrokes are necessary to select an address (an exact position on a page). Operator goes to desired position on the page by pressing [A], then presses the specific key for line position (1-16), then presses the third key which selects data position in the line (1-16). Characters are not entered until address sequence has been completed.

[C] **Clear**—Clears page and returns data to 0, 0 position (home).

[T] **Transmit**—Automatically transmits character in cursor position to computer and is used to transmit information line by line from the terminal memory to the computer. Since the terminal memory does not store carriage returns (end of line), the "@" symbol (shift [P]) is placed in memory at the end of each line. The "@" symbol stops transmission and the operator can manually press "return" to indicate end of line.

Other Special-Function Keys

Rept **Repeat**—Causes a character to be entered repeatedly. Press character key and Rept. key.

Rub Out **Deletes previous character.** When working with computer.

Shift **Allows entry of upper-case characters** indicated on keytops. Press shift, then upper-case character desired.

Ctrl **Control**—Allows entry of special control signals to computer, i.e., Ctrl and G is bell signal.

INDICATORS on FRONT of CT256.

P1-P4 Indicates page displayed.

Carrier Indicates when 2-kHz tone is received from computer via telephone or tape recording. **R-E**

new books

SIMPLIFIED COMPUTER PROGRAMMING—THE EASY RPG WAY, by Kelton Carson. TAB Books, Blue Ridge Summit, PA 17214. 240 pp. 8½x5¼ in. Hardcover $8.95; Softcover $5.95.

A computer, being a very complex system, requires literally thousands of steps and instructions to perform even a simple operation. The instructions are provided by a program which may be compared to a list of instructions for computing the square root, for example. Rather than actually write out the thousands of intructions for a computer, the programmer uses a language to have the computer prepare a program for him. By doing this, all that is left for the programmer is to write a few instructions in a few simple forms. The computer then translates the simple people language of the forms to the complex machine language of the computer. This book shows how it's done.

RESISTIVE AND REACTIVE CIRCUITS, by Albert Paul Malvino. McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020. 592 pp. 9¼x7¼ in. Hardcover $12.95.

A comprehensive textbook that provides all the information needed to prepare a technician for more advanced electronic courses. The first part of this book discusses resistive circuits with dc or ac sources as these are very prominent today because of direct-coupled circuits. The second part of the book covers reactive circuits such as transients, ac theory without using trigonometry or complex numbers. The final section of the book which does require a knowledge of trigonometry goes into extensive coverage of things such as phasor analysis, resonance and instantaneous ac analysis. Definitely a textbook quite valuable to anyone who wants to more fully understand both resistive and reactive circuitry.

SOLID-STATE IGNITION SYSTEMS, by R.F. Graf and G.J. Whalen. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46268. 136 pp. 8¼x5¼ in. Softcover $4.50 (in Canada $5.40).

Solid-state ignition is a fact of life in the modern car. There are many types of systems reflecting the various schools of thought about what constitutes the ideal solid-state ignition system. In this book, you will find all the known commercially available methods of solid-state ignition. The authors have conducted careful examinations of original equipment designs as well as add-on systems and all are presented here in great detail. The first chapter describes the phenomenon of spark ignition in easy-to-understand terms. Chapter two then relates how the conventional ignition system produces a spark. Chapter three covers semiconductors and how they are used in ignition systems. Chapters four and five give complete details on existing systems. The last chapter provides data for servicing and troubleshooting modern electronics ignition systems.

HANDBOOK OF MODERN SOLID-STATE AMPLIFIERS, by John D. Lenk. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 414 pp. 9¼x6 in. Hardcover $15.00.

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

TTL COOKBOOK, by Donald E. Lancaster. Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, IN 46268. 335 pp. 8¼x5¼ in. Softcover $8.95 (in Canada $10.75).

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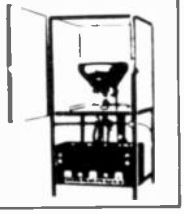

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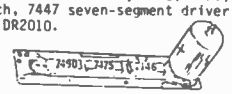

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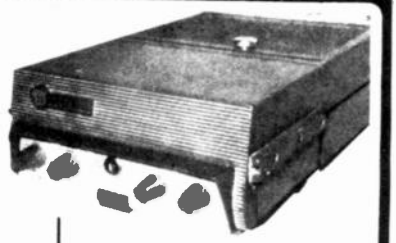

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EQUIPMENT REPORT
(continued from page 26)

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☐	2-MV53, micro-mini, axial yellow lens, yellow lite	1.00
☐	5-MV54, micro-mini, axial leads, red lens, red lite	1.00
☐	5-MV55, micro-mini, axial leads, red lens, red lite	1.00
☐	5-MV5012, red small dome lens, red lite, TO-18	1.00
☐	5-MV5013, sm. dome, 2 hi red dome, soft red diff. lite, TO-18	1.00
☐	5-MV5020, jumbo clear dome, visible, red, TO-18	1.00
☐	5-MV5054, red jumbo dome lens, TO-18 red lite, upright	1.00
☐	5-MV5080, TO-18, micro-mini red dome, red lite	1.00
☐	5-MV5080, TO-18, micro-mini flat clear lens, red lite	1.00
☐	1-MV5084, red bi-polar, solid state lamp V to 110-115VAC-DC	1.98
☐	3-MV5222, green jumbo dome, green lite, panel snap-in	1.00
☐	2-MV5282, micro-mini, green lens TO-18, green lite	1.00
☐	2-MV5322, yellow jumbo dome, yellow lite, panel snap-in	1.00
☐	1-MV5491, jumbo, Tri-State, RED, GREEN, OFF, special	1.49
☐	2-MT2, photo transistor, light sensor, TO-18	1.00
COUPLERS	☐ 2-MCT2, 1500V isolation photo transistor	1.00
	☐ 2-MCD2, 1500V isolation photo diode	1.00

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☐	1-5316 CLOCK CHIP, hobby	$1
☐	2-5005 MEMORY CALCULATOR CHIPS, 28-pin HOBBY	$1
☐	5-555 TIMERS, mini DIP, hobby	$1
☐	10-741 OP AMPS, mini DIP HOBBY	$1
☐	2 — 2N5296 35-WATT NPN PLASTIC TRANSISTORS, for NE-540	$1.
☐	2 — 2N6109 40-WATT PNP PLASTIC TRANSISTORS, for NE540	$1.
☐	10-1N82 GERMANIUM UHF diode, clip-in type*	$1.
☐	5-SCRs 7-AMP TO220, 6-12-24 prv, power tab	$1.
☐	10-MOS FETS, 3N187, 3N200, 3N128, TO-18, Fairchild*	$1.
☐	5-SCRS & TRIACS up to 25 amps. 6-12-24 prv, studs too	$1.
☐	2 — 2N3819, Texas, N channel, 6500 umho TO-18	$1.
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☐	50 — SILICON, glass rectifiers, computer, axial leads	$1.
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☐	6 — 1-AMP 1000 PIV, epoxy, submini, silicon rectifiers	$1.
☐	30 — 500MW ZENERS, axial 4, 6, 9, 10, 12V rectifiers	$1.
☐	4 — 2N3055, HOBBY, 40W npn silicon transistors, TO-3	$1.
☐	30 — 3-AMP RECTIFIERS, silicon, epoxy, assorted V, axial*	$1.
☐	2-EPOXY 2-AMP SILICON BRIDGE RECT. 1000 V "comb. type"	$1.
☐	1 — PHOTO TRANSISTOR, with darlington amp filter,	$1
☐	2 — PHOTO TRANSISTORS, with darlington amp, 2N5777, GE	$1
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	2-Sylvania 18,000V Matchstik TV rectifier, 4" x ⅛ with leads	$1.
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	2 — FET'S 2N5457 N channel 5000 umhos, TO-92 plastic	$1.
	10 — 1N914 fast switch diodes, silicon, 4 nanoseconds	$1.
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	30 — WORLD'S SMALLEST RECT. & zeners, 1W, assorted volts*	$1.
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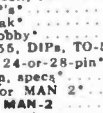
	1 — 2N5036 HI-PWR plastic trans 100 vceo, 7 amp 85 watts	$1.
	4 — 2N5296 HOBBY, 35 watts, plastic powers, NPN	$1.
	4 — 2N6109 HOBBY, 40 watts, plastic powers, PNP	$1.
	5 — PLASTIC 35W powers, npn, silicon, hobby 2N6121	$1.
	5 — PLASTIC 35W powers, pnp, silicon, hobby 2N6124	$1.
	2 — MOS FETS, N channel 10K umos 3N128, TO-18, RCA	$1.
	2 — MOS FETS, DUAL GATE, N chan. 3N187, TO-18, RCA	$1.
	2 — MOS FETS, DUAL GATE, N chan. 3N140, TO-18, RCA	$1.
	4 — RCA 2N3600 NPN, UHF transistors, tv-fm, TO-18, 1000mc	$1.
	2 — MPF-1000, Motorola MOS dual gate "The Claw"	$1.
	2 — 2N5655 200 hfe, 250 vceo, power tab $1.	

I.C. & LED HOBBY-ONICS



	4-DUAL 709, dip pak, op amps, untested	$1.
	10 — RCA CA-3000 OP AMPS, TO-5 case*	$1.
	4 — PHASE LOCK LOOPS, hobby 565, 560, 561*	$1.
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	10-MINI DIPS, OP AMPS, 709, 741, 301, 307, hobby*	$1.
	10-SIGNETIC OP AMP, 531, 533, 536, 550, 555, DIPs, TO-5*	$1.
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	1 -CALCULATOR ON A CHIP, hobby, exp. 40-pin, specs*	$1.
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	2 -2513 CHARACTER GENERATOR, Hobby for MAN-2	$1.
	5-IBM IC's with pc board, many parts, from computors	$1.
	1-AM RADIO-ON-A-CHIP, by Sprague, DIP, u test 'em	$1.
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	2-OPCOA SLA-11*, like MAN-5, green, 1-or-more segs gone,	$1.
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	5-MONSANTO opto isolators, no test, 1500V	$1.
	10-LED HOBBY SURPRIZE, asst. types, factory rejects, no test	$1.
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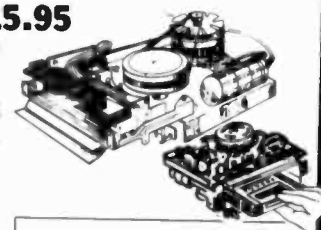
	2-MONSANTO MAN-4, .19" charac. 1-or-more segs missing, red	$1.
	5-MONSANTO MAN-3, .12" charac, red, 1 or more segs missing,	$1.
	2 — 3-DIGIT NATIONAL READOUTS, some digits good	$1.
	10-SPRAGUE DIPS, LINEAR OP AMPS, 2111 series, 2120 series	$1.
	1-MAN-3, "THE CLAW", one dot missing, 100% perfect	$1.
	2—MM5736 6-Digit Calculator on a Chip, hobby	$1.
	10—FAIRCHILD-NATIONAL, 9000 Series ICs, dips, hobby	$1.

8-TRACK PROFESSIONAL TAPE TRANSPORT $15.95

FOR HOME USE

Same type unit found in the most expensive home tape players. It's a complete 8-track player system with BUILT-IN PREAMP — just plug into any stereo amplifier (see some of our low-priced units). Excellent replacement unit, or you can design your own high-quality stereo tape system. It's the type you insert a cartridge to turn-on deck, then enjoy up to 80 minutes of non-stop, non-repeat stereo. Remove cartridge and player "shuts off" automatically. Built-in output controls in preamp. Features: 4 PROGRAM INDICATOR LIGHTS, automatic or manual program change, plays your car tapes at home. WOW-FREE precision fan-cooled motor, which operates off 115Vac. Requires external 12Vdc supply, for the electronics. With diagrams.



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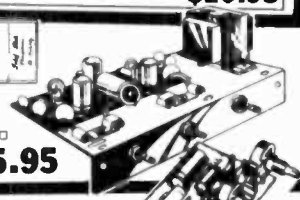
The factory "snipped" most of the cables to this compact 8 watt stereo unit with aluminum escutcheon plate. It's easy to use because we have all the cables marked ready to use. With power supply. 115vac. 3 controls, LEFT and RIGHT VOLUME controls for two speakers for balancing and center TONE control. With knobs. 7 x 3½ x 3½. Hookup spec sheets.



☐ **5.95**

4 WATT GUITAR AMP AMPEREX

Musical instrument amplifier at low, low price! Peak power output 10 watts. Two input circuits are equalized for normal or solo guitar. The four controls are VOLUME, TONE, TREMOLO INTENSITY and TREMOLO SPEED. There are terminals on board for normally open foot switch connection. Supply voltage 18vdc. Output to 8 ohm hi-quality speaker. Input impedance 33,000 ohms. Current drain 20 mils. External power supply required. Wt. 1 lb. With instructions, hookups and diagrams. Size 8 x 2⅝ x 3.

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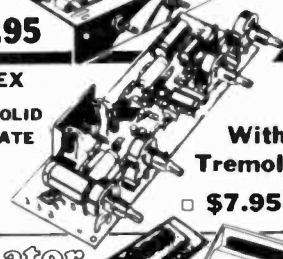

With Tremolo

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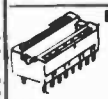
INTEGRATED CIRCUIT SOCKETS



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☐ 8-Pins (Mini DIP) .35

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• 7 Segments
30 mils
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☐ SLA-14*	GREEN
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For Class AB use. Basic includes: Signetic 540 30 transistor high power driver TO-5 "IC", with a pair of complimentary 35-watt plastic transistors, i.e. 2N5296 npn and 2N6109 pnp. With schematics, printed circuit and parts board layouts.

Calculator Basics

MAKE YOUR OWN CALCULATORS WITH OUR LOW PRICED

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BASIC KIT #1 — includes case, all-function Flex Key Keyboard, Cal Tech CT5002 calculator chip, 9-digit Antex LED display with built-on individual magnifiers, plus sheets.

BASIC KIT #2 — same as Basic #1 except calculator chip is National 8-digit MM5736.

BASIC KIT #3 — same as Basic #1 except calculator chip is National 6-digit MM5736 and 75492.

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☐ **$1.49** 3 for $3

Removed from new equipment! Includes popular 2N174 'doorknob' transistor TO-36, germanium, PNP 160 watts, VCBO 80V, 15 amps, 40 hfe. For ignition, high power transmitters, etc. Mounted on heat sink 5 x 2½ x 1¼".

LOWEST PRICES ON NATIONAL "CALCULATOR CHIPS"

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NEW! NATIONAL LM-340T VR's

• TO-220 Case • 1 Amp
▲ POSITIVE VOLTAGE

Type	Volts
☐ LM-340-05T	5 v
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☐ LM-7520	☐ LM-7523	☐ LM-7526	Buy 3
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Rare buy of these popular precision modules that are used by hams, clock enthusiasts, hobbyists. By Monitor, Type 850. Freq: 4.000 MHz. Accuracy to .001. Requires 5VDC. Generates a square wave on output. Size: 1¼ x 1 x ½".

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3 for $1 **39¢ ea**

•For RTTY
•Printed Circuits
•For Unique Panel Switches

Mfd. by OAK (Ham's note, RTTY, too) data systems, same as used in Keyboard Calculator, SPST. Normally Open, 24V 1 amp contacts. Characters and letters easily changed. ⅝" high. Printed circuit.

†Blue top, white characters. •White top, black numbers.

No.		
☐ 0•	☐ 8•	
☐ 1•	☐ 9•	
☐ 2•	☐ CE†	
☐ 3•	☐ CL†	
☐ 4•	☐ + =†	
☐ 5•	☐ ÷ †	
☐ 6•	☐ × †	
☐ 7•	☐ ••	

CALCULATOR KEYBOARD SWITCH KITS

Kit of 17 for $4.95

Each switch made by Oak #415, SPST normally open, 24V 1 amp contacts. Kit includes 0-to-9 (10 switches white with black numerals) decimal, white with black dot, and CE, CL and 4 functions blue with white characters.

☐ 10-pc. kit, 0-to-9 only same type as above. **2.50**

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	Output		Sale
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☐	18.0VCT	@ 2A	2.50
☐	150.0V	@ 50MA.	
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*Nixie tube transf.

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3.3 UFD/35V	14c	12c	11c	220 UFD/16V	24c	18c	17c
4.7 UFD/35V	14c	12c	11c	220 UFD/25V	35c	25c	24c
10 UFD/16V	14c	12c	11c	330 UFD/16V	35c	25c	24c
10 UFD/25V	14c	12c	11c	330 UFD/25V	44c	35c	32c
22 UFD/16V	14c	12c	11c	470 UFD/16V	37c	30c	27c
22 UFD/25V	15c	13c	12c	470 UFD/25V	49c	39c	35c
33 UFD/16V	15c	12c	11c	1000 UFD/16V	49c	39c	35c
33 UFD/25V	17c	13c	12c	1000 UFD/25V	75c	60c	55c
47 UFD/16V	17c	14c	13c	2200 UFD/16V	75c	60c	55c
47 UFD/25V	19c	15c	14c				

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EN918	TO-106	.21	.185	.165	EN930	TO-106	.21	.185	.165
EN2222	TO-106	.21	.185	.165	EN2369A	TO-106	.21	.185	.165
2N2712	TO- 98	.18	.160	.145	EN2907	TO-106	.21	.185	.165
2N3391A	TO- 98	.22	.190	.175	2N3392	TO- 98	.22	.190	.175
2N3393	TO- 98	.22	.190	.175	2N3394	TO- 98	.22	.190	.175
2N3563	TO-106	.20	.175	.160	2N3565	TO-106	.20	.175	.160
2N3638	TO-105	.20	.175	.160	2N3638A	TO-105	.20	.175	.160
2N3640	TO-106	.22	.190	.175	2N3641	TO-105	.20	.175	.160
2N3643	TO-105	.20	.175	.160	2N3645	TO-105	.20	.175	.160
2N3646	TO-106	.22	.190	.175	2N3904	TO- 92	.25	.225	.200
2N3906	TO- 92	.25	.225	.200	2N4124	TO- 92	.27	.240	.220
2N4126	TO- 92	.27	.240	.220	2N4401	TO- 92	.32	.290	.260
2N4403	TO- 92	.32	.290	.260	2N5087	TO- 92	.27	.240	.220
2N5089	TO- 92	.27	.240	.220	2N5129	TO-106	.19	.170	.150
2N5133	TO-106	.19	.170	.150	2N5134	TO-106	.19	.170	.150
2N5137	TO-106	.19	.170	.150	2N5138	TO-106	.19	.170	.150
2N5139	TO-106	.19	.170	.150	2N3055	TO- 3	1.35	1.20	1.09

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NPN DARLINGTON TRANSISTOR

MPSA13 TO- 92 Min. DC Current Gain of 5,000 at 10mA .36 .320 .290

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5 each of the 85 standard 10% values (2.2-22M) ½ W Resistors (425 pcs.) Sorted by value $12/set 2-4 are $11/set 5-9 are $10/set.

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Value	1	10	100
.001	5c	3.5c	3c
.022	6c	4c	3.5c
.047	6c	4c	3.5c
.047	9c	6c	5.3c
.1	12c	9c	7.5c

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$1.80 ea.

L129	5V	600mA
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$5.00

5 V. common 9 pin tube base

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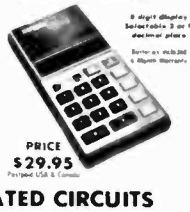
8 Pin DIP Solder 35c
14 Pin DIP Solder 45c
16 Pin DIP Solder 50c
24 Pin DIP Solder $1.25

Utronix 1100 Calculator



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747 Dip DUAL OP AMP	$1.10	10/$10.50	748 Minidip OP AMP	60c	10/$ 5.50

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	1	100		1	100		1	100
7400N	32c	28c	7437N	51c	46c	7476N	60c	55c
7401N	32c	28c	7438N	51c	46c	7480N	74c	65c
7402N	32c	28c	7440N	32c	28c	7482N	$1.02	91c
7403N	32c	28c	7441N	$1.45	$1.27	7483N	$1.58	$1.40
7404N	35c	31c	7442N	$1.20	$1.07	7486N	60c	55c
7405N	35c	31c	7445N	$1.62	$1.44	7489N	$4.50	$4.00
7406N	52c	46c	7446N	$1.30	$1.10	7490N	85c	72c
7407N	52c	46c	7447N	$1.30	$1.10	7491N	$1.37	$1.22
7408N	36c	32c	7448N	$1.35	$1.15	7492N	85c	72c
7409N	36c	32c	7450N	32c	28c	7493N	85c	72c
7410N	32c	28c	7451N	32c	28c	7494N	$1.20	$1.07
7411N	35c	31c	7453N	32c	28c	7495N	$1.20	$1.07
7413N	63c	56c	7454N	32c	28c	7496N	$1.20	$1.07
7416N	50c	44c	7459N	32c	28c	74107N	55c	50c
7417N	50c	44c	7460N	32c	28c	74121N	70c	60c
7418N	35c	31c	7470N	36c	32c	74122N	72c	62c
7420N	32c	28c	7472N	40c	35c	74123N	$1.11	99c
7423N	75c	67c	7473N	52c	45c	74141N	$1.61	$1.43
7426N	36c	32c	7474N	52c	45c	74150N	$1.56	$1.39
7430N	32c	28c	7475N	85c	72c	74151N	$1.20	$1.07

74153N	$1.58	$1.40	74192N	$1.80	$1.60
74154N	$2.25	$2.00	74193N	$1.80	$1.60
74155N	$1.46	$1.29	74196N	$2.78	$2.47
74156N	$1.17	$1.04	74197N	$2.78	$2.47
74157N	$1.56	$1.39			
74158N	$1.56	$1.39			
74160N	$1.95	$1.74			
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MV4 2 WATT hi-pwr red (STUD)	2.25	20.00
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7403	.28	2.50
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7405	.28	2.50
7406	.40	3.50
7408	.30	2.60
7410	.28	2.50
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7416	.45	3.80
7420	.28	2.50
7426	.35	3.00
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7445	1.10	9.00
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Circle 107 on reader service card

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Circle 101 on reader service card

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WITH ESCUTCHEON

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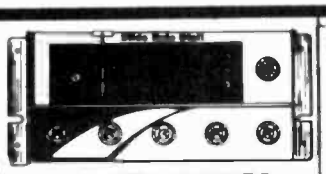

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- All Solid State, Printed Circuitry
- Slide Rule Dial
- All Purpose, All Family System!

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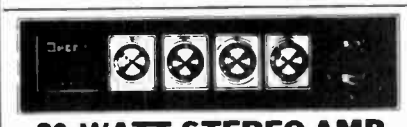
Has controls on front panel, PHONO-STEREO-AM-FM, MONO, FM STEREO, GUITAR, TAPE, MIKE master control switch, LOUDNESS, BALANCE, TREBLE, BASS controls, with power ON-OFF rocker switch, and AFC ON-OFF. Designed for all audio-philes to use as wall unit in DEN or FAMILY ROOM, or control unit by easy chair in family room, or for those who wish to design their own console or modular system. With 6 ft. 115 VAC cord and plug. Only 13 x 7 x 3½" deep. No escutcheon, but we include template for one, plus diagram. Shpg. wt. 3 lbs. With knobs.



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- 4-Channel Sphr. Systems!

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- All Purpose, All Family System!

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Has the following controls on front panel, PHONO-STEREO-AM-FM, MONO, FM STEREO, TAPE, master control switch, LOUDNESS, BALANCE, TREBLE, BASS controls, with power ON-OFF rocker switch. Designed for all audio-philes to use as wall unit in DEN or FAMILY ROOM, or control unit by easy chair in family room, or for those who wish to design their own console or modular system. With 6 ft. 115 VAC cord and plug. Only 13 x 7 x 3½, plus diagram. Shpg. wt. 3 lbs. With knobs.

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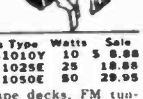

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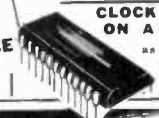

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723	Voltage Regulator	DIP	.69 ea.
739	Dual HI Perf. Op AMP	DIP	1.19 ea.
741	Comp. Op AMP	MINI-DIP, TO-5	.35 ea.
747	Dual 741 Op Amp	TO-5 or DIP	.79 ea.
748	Freq. Adj. 741	MINI-DIP	.39 ea.
1303	Stereo Pre-Amp	DIP	.89 ea.
1304	FM Mulpx Stereo Demod	DIP	1.19 ea.
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1458	Dual Comp. Op. Amp.	MINI-DIP	.69 ea.
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74H08N	.44
74H10N	.44
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		74175N	1.92
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74L04N	.39
74L10N	.34
74L20N	.39
74L42N	1.62
74L47N	1.62
74L51N	.34
74L73N	.74
74L74N	.89
74L90N	1.62
74L93N	1.74
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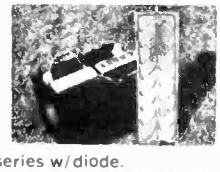

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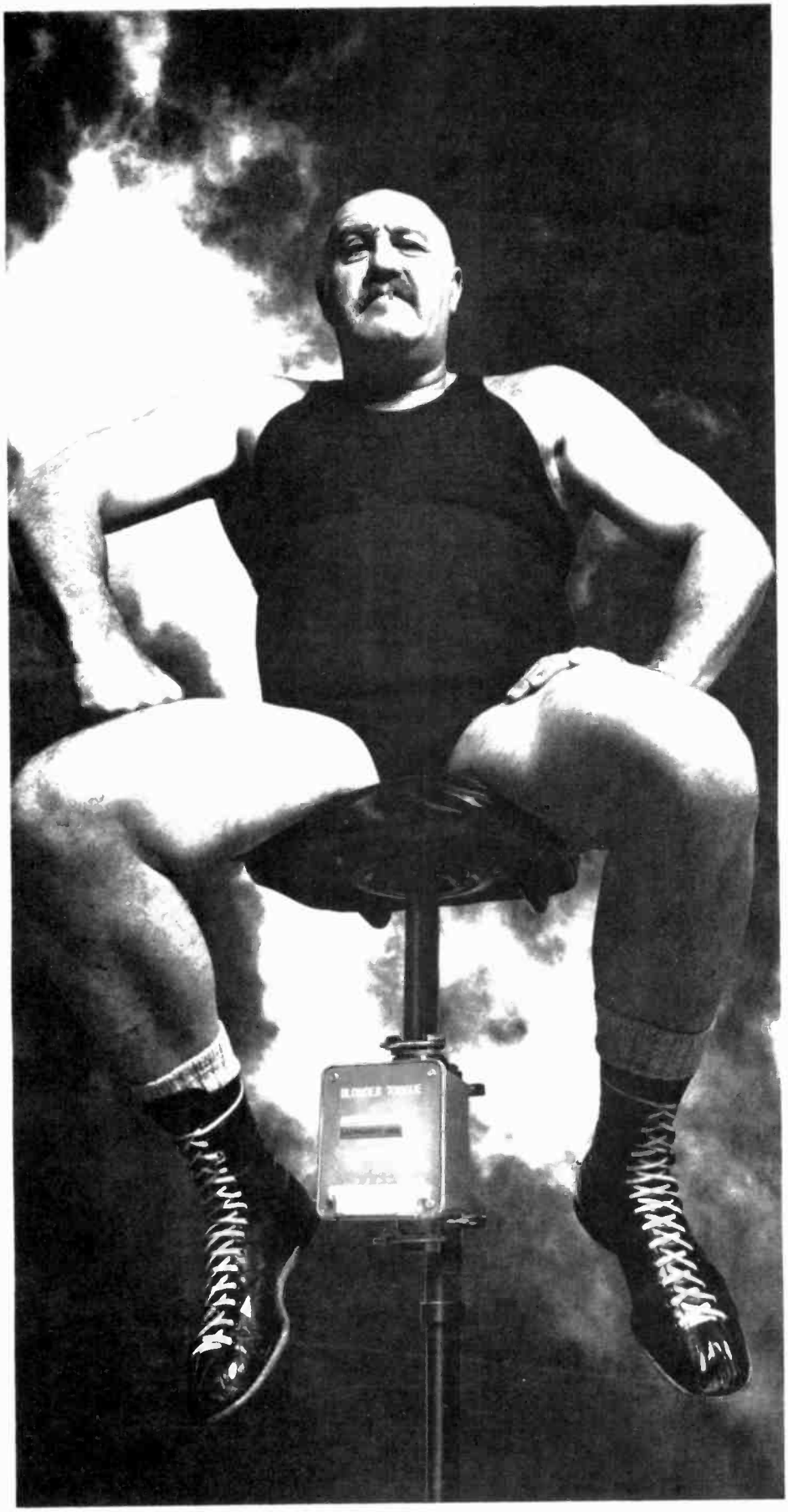
Think of him as a 250lb. antenna.



We know you don't have a 250lb. antenna.

But when the winds get rough, you need every bit of turning power an antenna rotor can muster. The new, super power Blonder-Tongue ULTRAMATIC 1000 gets the antenna to the precise point for each station, consistently, accurately.

And, by doing this, it gives the best reception by assuring ghost-free color reception and minimum multipath stereo distortion.

These exclusive features make it all possible.

Highest starting and running torque (175 to 200 inch lbs.) motor uses filtered DC power supply.

Accurate 2-degree resetting push-to-start silent control, unique direction sensing circuit utilizing five wire control cable; differential servo sensing amplifier with solid-state switching; hermetically-sealed power relay automatically disconnects rotor when not in use.

Reliability – weatherproof terminals use foam-filled pad; long life, self-lubricated Celcon gears; bronze worm gear and high strength sintered steel ring gear lock antenna in position; corrosion-proof cast aluminum housing, fully protected against lighting and power surges; unbreakable plastic control box.

Install the ULTRAMATIC 1000 it performs well under the most adverse conditions and will stand up for years and years.

Blonder-Tongue Laboratories, Inc. One Jake Brown Road, Old Bridge, N.J. 08857

Blonder-Tongue
Ultramatic 1000

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SUBBER™

TV Service Instruments for signal circuit analyzing.

When Castle introduced the TV Tuner SUBBER* analyzing instrument a couple of years ago it became the first practical way to easily test the VHF tuner, UHF tuner and i.f. amplifier system of any TV receiver. Being lightweight, self contained and battery powered the TV Tuner SUBBER* Mk. IV is the first such instrument which may be carried on service calls and used with ANY color or black and white TV receiver . . . at $45.95 for the battery powered Mk. IV, or $54.95 for the a.c. plus battery powered Mk. IV-A the instruments have been known to pay for themselves in TIMESAVING in the first two weeks of use!

Now we have introduced the Mk. V Master SUBBER*, an instrument which is absolutely unique . . . there is nothing else like it anywhere! It is completely portable and battery powered, practically foolproof in it's simplicity of operation when testing ALL the signal stages of any color or black and white TV receiver. The substitution signals available allow tests of the following stages: VHF tuner, UHF tuner, each video i.f. amplifier, video detectors, video amplifiers, 4.5 MHz sound i.f. amplifiers, sound limiter, sound detector and audio amplifier. It includes a signal level meter for testing the antenna signal. Inbuilt telescopic antenna makes the meter adaptable for true field strength measurements. Inbuilt monitor loudspeaker ensures foolproof substitution tests . . . every time!

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All SUBBER* instruments come complete with batteries, connecting cables and comprehensive instruction manual. The Master SUBBER* and Mk. IV-A TV Tuner SUBBER* come complete with wall plug-in transformer for 120vac 60 Hz operation.

As an added bonus, all SUBBER* instruments enable use of the high speed agc system analyzing procedure invented by Castle . . . the first practical method for analyzing agc system defects without confusion.

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These instruments boast the extra features of all Castle products — advanced technology — modern styling — and they work!

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