Radio-Electronics

JAPANESE TRANSISTOR REPLACEMENTS

75¢ ■ AUG. 1975

Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

COLOR TV CAMERA
Build It Yourself

MATV SPLITTERS
See How They Work

USING YOUR SCOPE
To Speed Service Jobs

HI-FI LAB TESTS
- **Kenwood KR-5400 Receiver**
- **Crown VFX-1 Filter/Crossover**

TAPE DECK ELECTRONICS
Make The Reels Go Round
Without Jamming The Tape

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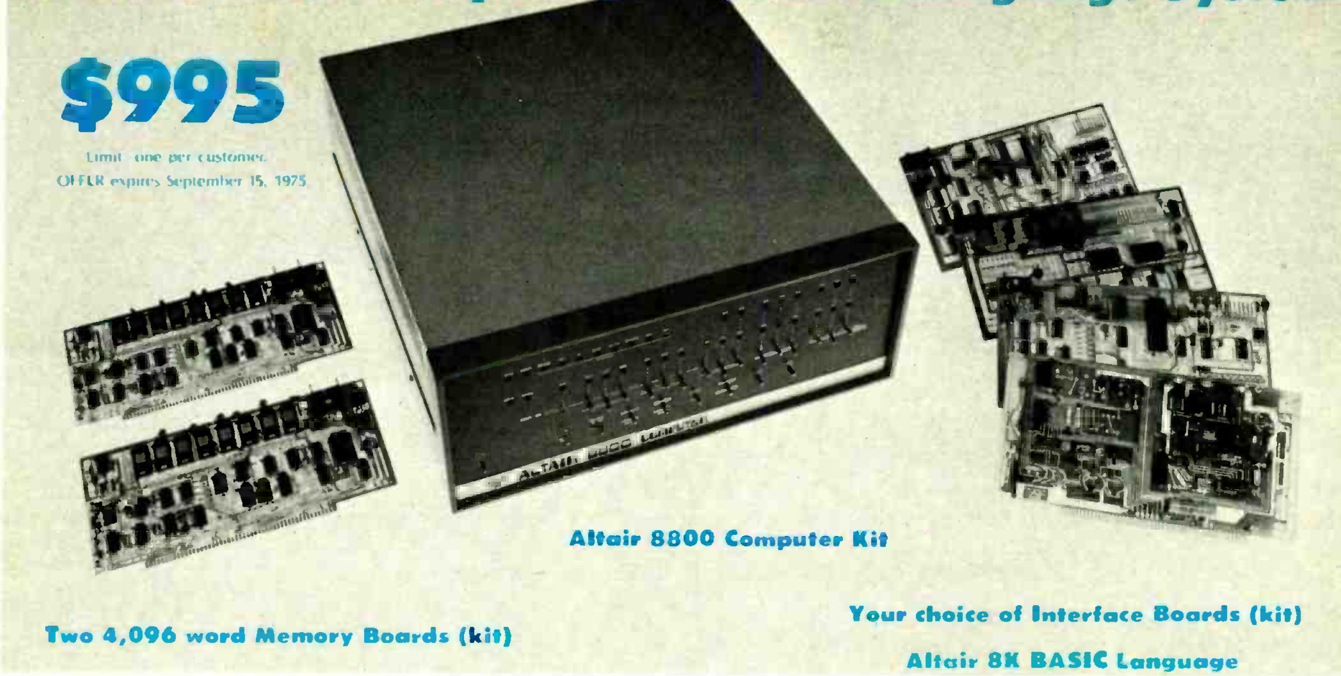
LIQUID-CRYSTAL CLOCK
Has 2-Inch Readouts

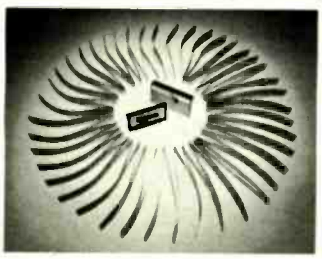
Clinic

shooting Charts ★ State-Of-Solid-State

World's Most Inexpensive BASIC Language System



Altair 8K BASIC Language. This language was chosen for the Altair Computer because of its versatility and power and because it is easy to use (comes with complete documentation). Altair 8K BASIC has many features not normally found in BASIC language including an OUT statement and corresponding INPut function that allows the user to control low speed devices (machine control without assembly language). Leaves 1750 words in 8K machine for programming and storage.



NOTE: Altair BASIC comes in either paper tape or cassette tape. Specify when ordering.

Interface Board Options. The *Parallel Interface Board* is used to connect the Altair 8800 to external devices that send and receive parallel signals. Many line printers require a Parallel Interface Board. The *RS232 Serial Board* is used to connect the Altair 8800 to external devices that send and receive RS232 serial signals. Most computer terminals require an RS232 Serial Interface Board. The *TTY Serial Interface Board* is used to connect the Altair 8800 to an ASR-33 or KSR-33 teletype (20 milliamp current loop). The *TTL Serial Interface Board* is for custom interfacing. The *Audio Cassette Interface Board* is used to connect the Altair 8800 to any cassette tape recorder. It works by changing the electrical signals from the computer to audio tones. It can be used to store unlimited amounts of information coming out of the computer and it can be used to put information back into the computer.

PRICES:

Altair Computer kit with complete assembly instructions	**$439**
Assembled and tested Altair Computer	**$621**
1,024 Word Memory Board	**$176 kit and $209 assembled**
4,096 Word Memory Board	**$264 kit and $338 assembled**
Full Parallel Interface Board	**$92 kit and $114 assembled**
Serial Interface Board (RS232)	**$119 kit and $138 assembled**
Serial Interface Board (TTL or TTY—teletype)	**$124 kit and $146 assembled**
Audio Cassette Interface Board	**$128 kit and $174 assembled**
4K BASIC language (when purchased with Altair, 4,096 words of memory and Interface Board)	**$60**
8K BASIC language (when purchased with Altair, two 4,096 word memory boards and Interface Board)	**$75**
COMTER II	**$780 kit**
Teletype ASR-33	**$1500 (assembled only)**

Input Output Devices. The Comter II Computer Terminal has a full alpha-numeric keyboard and a highly-readable 32-character display. It has its own internal memory of 256 characters and complete cursor control. Also has its own built-in audio cassette interface that allows you to connect the COMTER II to any tape recorder for both storing data from the computer and feeding it into the computer. Requires an RS232 Interface board.

The Standard ASR-33 Teletype prints 10 characters per second. It has a built-in paper tape reader and punch. Has standard 120 day Teletype warranty. Requires a Serial TTY Interface board.

NOTE: The Altair 8800 can be connected to any number of input/output devices other than the ones listed above.

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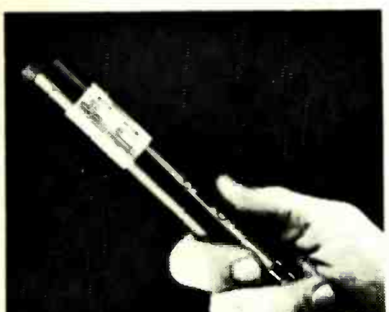
Warranty: 90 days on parts for kits and 90 days on parts and labor for assembled units. Prices, specifications and delivery subject to change.

Circle 2 on reader service card

Whistles while you work.



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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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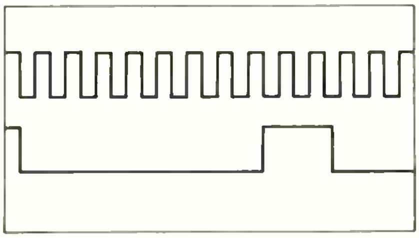
AUGUST 1975 Vol. 46 No. 8

ON THE COVER

If you've always wanted to build a digital clock, but thought they were too complicated, try this one. It's a snap to assemble and has giant 2-inch high numerals. . . . . ***see page 33***

INSIDE THE KENWOOD KR-5400 receiver. For all the facts on how well it works see our complete lab-test report on page 36.



INPUT AND OUTPUT WAVEFORMS from a BCD counter are only one of the things you'll learn to measure with your scope.
. . . . see page 52

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looking ahead

Conservation sacrifice

Two controversial "improvements" in color-TV sets may be sacrificed on the altar of energy conservation. These are the power race, which is seeing ever-increasing high-voltage to force more brightness from the picture tube, and the trend toward 110-degree wide-angle short picture tubes. The nation's television manufacturers have met with Commerce Department officials and have been assigned the "voluntary" goal of reducing the power consumption of the average television set—both color and monochrome—by 40% below the 1972 level by 1976. The original goal was 25%, easily accomplished by the already nearly complete switch to solid-state. But government officials changed their tune and persuaded the industry to switch to the far tougher target of 40%. In the opinion of some top industry engineers, this means changing priorities for the near future.

The high-power race is something which most manufacturers haven't been too excited about anyway—it's been a defensive maneuver to avoid being out-brightened by the competition. The eventual switch to 110-degree tubes in color has always been a foregone conclusion. It happened in black-and-white, resulting in more compact cabinets. In Western Europe, 110-degree tubes are the general rule. But the wider deflection angle requires higher power, and although there will be some 110-degree tubes introduced in the near future, it's now probable that the majority of television manufacturers will stick predominantly with 90-degree deflection in order to meet the government guidelines.

VTR tape economy

Speaking of Sony, last month I reported on its Betamax home videocassette recorder. Now it has been introduced into the United States market. The first unit to be sold here will be a combination videocassette recorder and 19-inch color-TV set, with a list price of $2,295, to be offered in a few large cities here this fall. It's now learned that one of the secrets of Betamax's extreme conservation of magnetic tape is the elimination of the guardband between the diagonal video tracks. The color phase-polarity is reversed on every other line, permitting the tracks to abut directly against one another. Any remaining cross-talk between tracks is eliminated by the use of a comb filter.

In videotape, particularly videotape designed for the home, the name of the game is economy of tape. Last month I gave some examples of the tape economy of various systems, and mentioned the fact that RCA's developmental MagTape SelectaVision had undergone a major revision which almost doubles its tape economy. (The figure given last month was for the original system.) The home videocassette race may well be won by the unit that gobbles up the least area of tape per hour, whether it's ¼-inch, ½-inch or ¾-inch tape. Therefore, I've prepared the following table, based on published specs, of the various videocassette and cartridge systems in the order of increasing approximate usage of tape to record for an hour. The systems marked with asterisks are developmental and subject to change. They are all helical scan except the German BASF Longitudinal Video Recording (LVR) system that lays down 28 longitudinal tracks on ¼-inch tape, and American Videonetics that uses an eight-head assembly revolving at 7,200 rpm, laying down a track nearly perpendicular to the tape. The Akai ¼-inch unit, although still an open-reel machine, is included here because the tape could easily be placed in a cassette or cartridge. EIA-J Type I is the standard Japanese cartridge recorder.

System	Speed (ips)	Tape Width	Sq. ft./hour
Sony Betamax	1.57	½"	20.6
*BASF LVR	120.00	¼"	26.8
*RCA MagTape	1.53	¾"	28.7
V-Cord (Japan)	3.75	½"	46.9
Cartrivision	3.8	½"	47.5
*Amer. Videonetics	2.88	¾"	54.0
Akai	10.0	¼"	62.5
Philips VCR	5.6	½"	70.0
Sony U-Matic	3.75	¾"	70.3
EIA-J Type I	7.5	½"	93.8

New TV projectors

Sony, the mini-TV specialist, has introduced two maxi-TV projection systems—one for home and the other for industrial-educational use. Scheduled for immediate marketing in New York, Chicago and Los Angeles is a one-piece furniture-housed home projection TV with a Kodak Ektalite screen that measures 40 inches diagonally. The picture is projected from a special 12-inch Trinitron receiver through a lens-and-mirror system. The receiver is housed in a pull-out drawer. When the set is not in use, a vertical flexible tambour door—like that used on a roll-top desk—covers the screen. Sony says the brightness is 20 foot-lamberts, adequate for viewing in a dimly lit room and nearly twice the brightness of Sony's earlier industrial-institutional unit with a slightly smaller screen. The price is $2,500. Two other home projection systems are on the market—the Muntz Home TV Theater with a 30 × 40-in. screen (about 35 inches diagonally) at $1,995, and the Advent Videobeam two-piece unit whose screen measures about seven feet diagonally.

The other Sony projection system has a screen measuring 12 feet diagonally and uses three specially made 12-inch Trinitron picture tubes as light sources—one for each color. The green tube projects directly onto the screen through a lens system, while the red and blue images are combined using a dichroic mirror and projected through a second lens system. Altogether, the system uses 13 lenses. This system is claimed to have a projected picture more than 20 foot-lamberts in brightness. The screen is placed 11.5 feet from the projector. The system costs about $23,300, as compared with $44,000 for the G-E Light-valve projector, with which it competes.

Quintaphonics

The first movie claiming to have "Quintaphonic sound" is the Columbia release, "Tommy." The sound system, developed by John Mosley, uses a QS matrix to produce four channels from two magnetic sound tracks, feeding speakers at the corners of the theatre. A third track provides the fifth channel, which is fed to a speaker system directly behind the screen. Over 50 theaters have been equipped with decoders and addtional amplifiers and speakers.

Pay-TV via bird

United Artists-Cablevision, which owns cable TV systems serving 182,000 subscribers, plans to feed special closed-circuit pay-TV programming to its system by space satellite. It will install earth stations at each of its system locations to receive programming from the Home Box Office, a pay-TV nework. The first earth station will serve CATV systems in Fort Pierce and Vero Beach, FL, later this year. It will be followed in 1976 by installations serving Fort Smith, AR; Laredo, TX; Yuma, AZ; El Centro, CA, and Pasco and Kennewick, WA.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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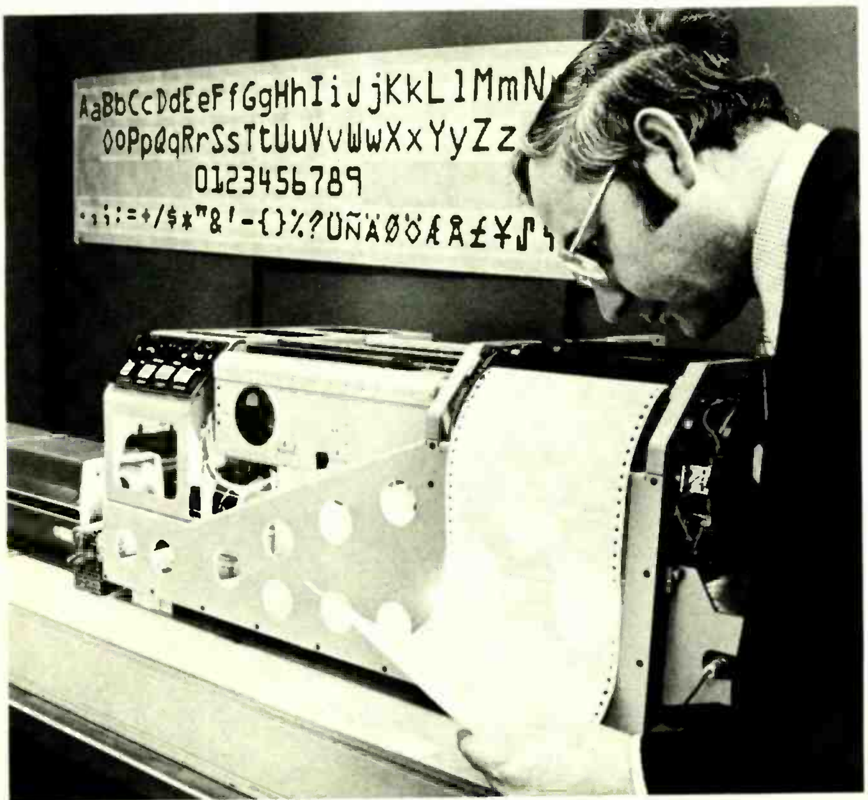
New non-impact printer writes with laser beam

A new non-impact printer just tested by RCA for the US Army uses a laser to transfer digital communications alphanumerics onto ordinary paper. The messages are transferred by a process in which the laser scans its beam across a dye-coated plastic ribbon in contact with the paper. Called TLP (tactical line printer), the system has seven speeds—55, 110, 220 and 440 lines-per-minute for serial input and 273, 605 and 900 lines-per-minute for parallel input.

The TLP is interfaced to receive digital communications from a wide variety of sources, including satellite ground terminals. It decodes the digital data received and stores it in a buffer memory one line at a time. It then produces an electrical signal that modulates the laser's intensity as it scans the plastic ribbon, producing a series of dots. The dots form the characters as the laser continues to scan, reproducing a line in 19 horizontal scans.

Advantages of the TLP are claimed to be less maintenance, since a laser has no moving parts to break down; cost savings through use of ordinary paper, and quietness, since the printer is a non-impact type.



MARTIN L. LEVINE OF RCA EXAMINES COPY FROM THE NEW PRINTER that uses a laser. An enlarged view of the characters is shown in the background.

Dr. Coolidge, inventor of tungsten filament, X-ray, dies at age 101

Dr. William D. Coolidge, retired General Electric vice president and director of research, died February 3 after a short illness. He was 101 years old last October.

Born on a small farm in Massachusetts, Coolidge attended the Massachusetts Institute of Technology. He graduated in 1896, $4,000 in debt for the money borrowed to put him through college. He then worked as an assistant in physics at M.I.T. Obtaining a scholarship, he studied in Germany, receiving his PhD (summa cum laude) from the University of Leipzig in 1899. Returning to M.I.T., he taught until 1905, leaving to join General Electric.

Within two years, Dr. Coolidge succeeded in producing a ductile form of the notoriously brittle and unworkable metal, tungsten. Drawn into thin filaments, it became the ideal material for electric lamp filaments. By 1911 it had replaced the brittle and short-lived materials heretofore used and ushered in an era of cheap, long-life electric lamps that could be used in any position and that would withstand the shock of automobile operation and other rough usage.

The tungsten filament led to another invention—the Coolidge X-ray tube. A cold-cathode, gaseous type of X-ray tube already existed—mostly as a laboratory curiosity. The tubes were erratic and tended to change their characteristics each time they were used. The Coolidge tungsten filament hot-cathode tube could be evacuated to a high vacuum and the output predetermined and accurately controlled. Patented in 1916, the new Coolidge tubes also used tungsten in the "target" or anode.

DR. COOLIDGE as he appeared at 81.

During World War I, Drs. Coolidge and Irving Langmuir—also of General Electric—developed the first successful submarine detector. After the war, he went on to develop new high-voltage X-ray tubes, with potentials up to 2 million volts.

Dr. Coolidge became director of the General Electric Research Laboratory in 1932. Under his direction, the laboratory developed, among other things, the sodium vapor lamp, Fernico glass seals for vacuum tubes, the electric blanket, "invisible" glass, new permanent magnet alloys and high-quality magnetic steel.

During Warld War II, he was associated with the atomic bomb project. He retired in 1944, having remained two years beyond normal retirement age because of the need for top scientists during the early stages of the war.

On his 100th birthday, G-E employees presented Dr. Coolidge with a huge birthday cake decorated with 100 tiny tungsten lamps (**Radio-Electronics,** March 1974, page 12) and with the tungsten anode of an early Coolidge X-ray tube at its center.

Besides his PhD from Leipzig (renewed with a Golden Anniversary PhD in 1949),

(continued on page 12)

Get the news before it's news...
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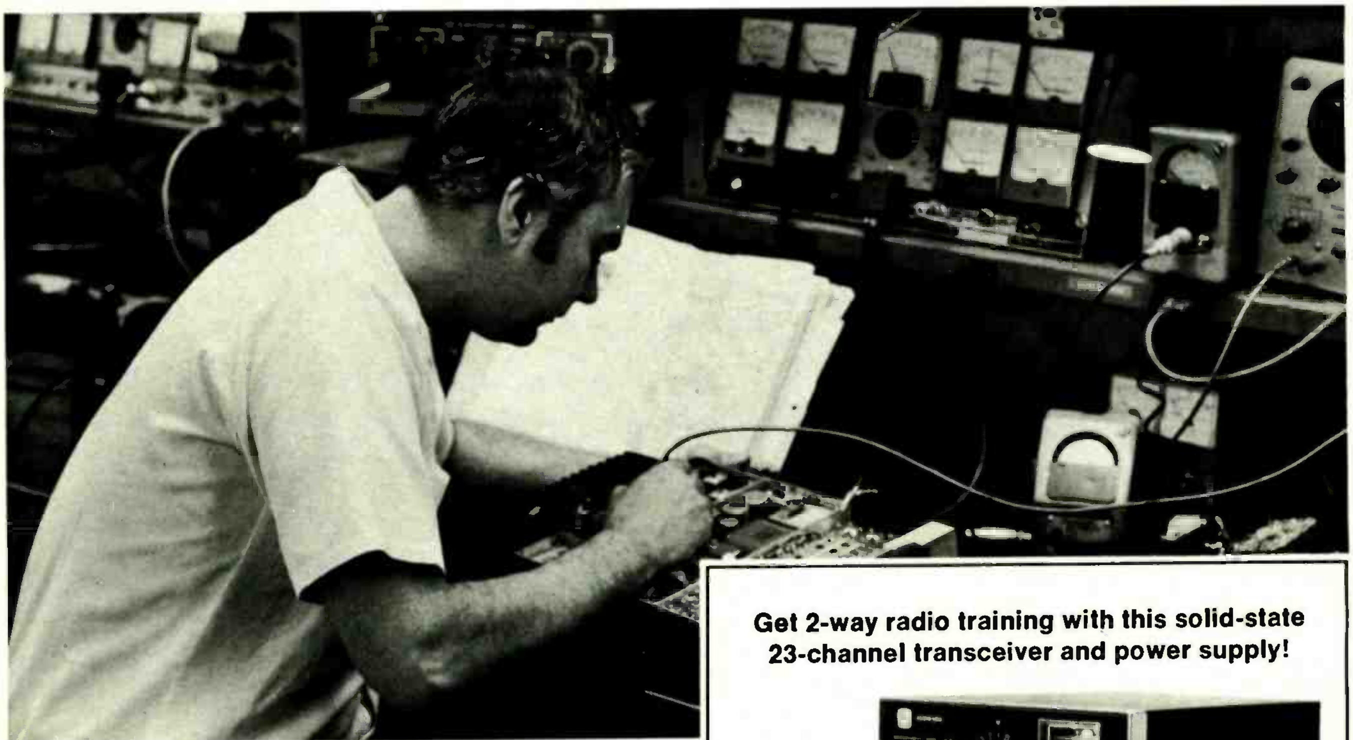

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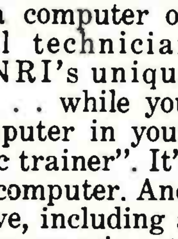

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new & timely

(continued from page 6)

Dr. Coolidge held honorary doctorates from at least half a dozen universities in North and South America. He held 83 patents, was a member or honorary member of a large number of scientific societies and received numerous awards and medals from institutions and societies in the United States, Britain, Chile and other countries, including the honorary M.D. degree of the University of Zurich, an honor seldom bestowed on an American layman.

Night-vision bifocals help firefighters

Helicopter fire-fighters of Los Angeles County have been made more effective in forest-fire missions with the help of special night-vision goggles.

Helicopters have proved their worth in daytime fire-fighting, especially in fighting forest fires. They can be even more effective at night, when temperatures and wind speeds often drop and fire spread is slower. But while a fire itself is conspicuous, it does a poor job of lighting up its surroundings. Ability to see the area and size-up the situation gives the fire-fighter an edge he cannot have if "working in the dark."

The two-pound goggles, made by ITT Electro-Optical Products Division, Roanoke, VA, use any low-level light source—firelight, starlight, moonlight or artificial light—to give the wearer an electronically amplified picture of whatever's beneath. The goggles are bifocal, so the pilot can read his instrument panel as well as study the terrain below.

In more than 50 missions to date, the Los Angeles County Fire Department reports, the fires have been brought under control sooner than would have been possible under daytime flying conditions.

One cable for power and video in latest CCTV camera

The recently introduced RCA VidiPlex CCTV camera, model TC1025, has made installation easier by using a common cable for the video signal and power supply. The camera consists of two units—a camera head and power supply connected by an RG-59/U cable. The single conductor carries 24-volts DC to the camera head and the video to the monitor.

LATEST IN RCA'S TC1000 FAMILY has 2:1 interlace and one cable for video and power.

A 2:1 interlace scanning network, as used in standard broadcast work, improves vertical resolution and prevents picture crawl, often objectionable in random-interlace surveillance cameras. Images from several cameras can be presented simultaneously on the same screen, and cameras can be locked together. **R-E**

FIRE-FIGHTING HELICOPTER PILOTS of Los Angeles County wear these bifocal light-amplifying goggles that permit them to see at night while flying over dangerous mountain terrain to fight forest fires, while at the same time keeping an eye on the cockpit instruments.

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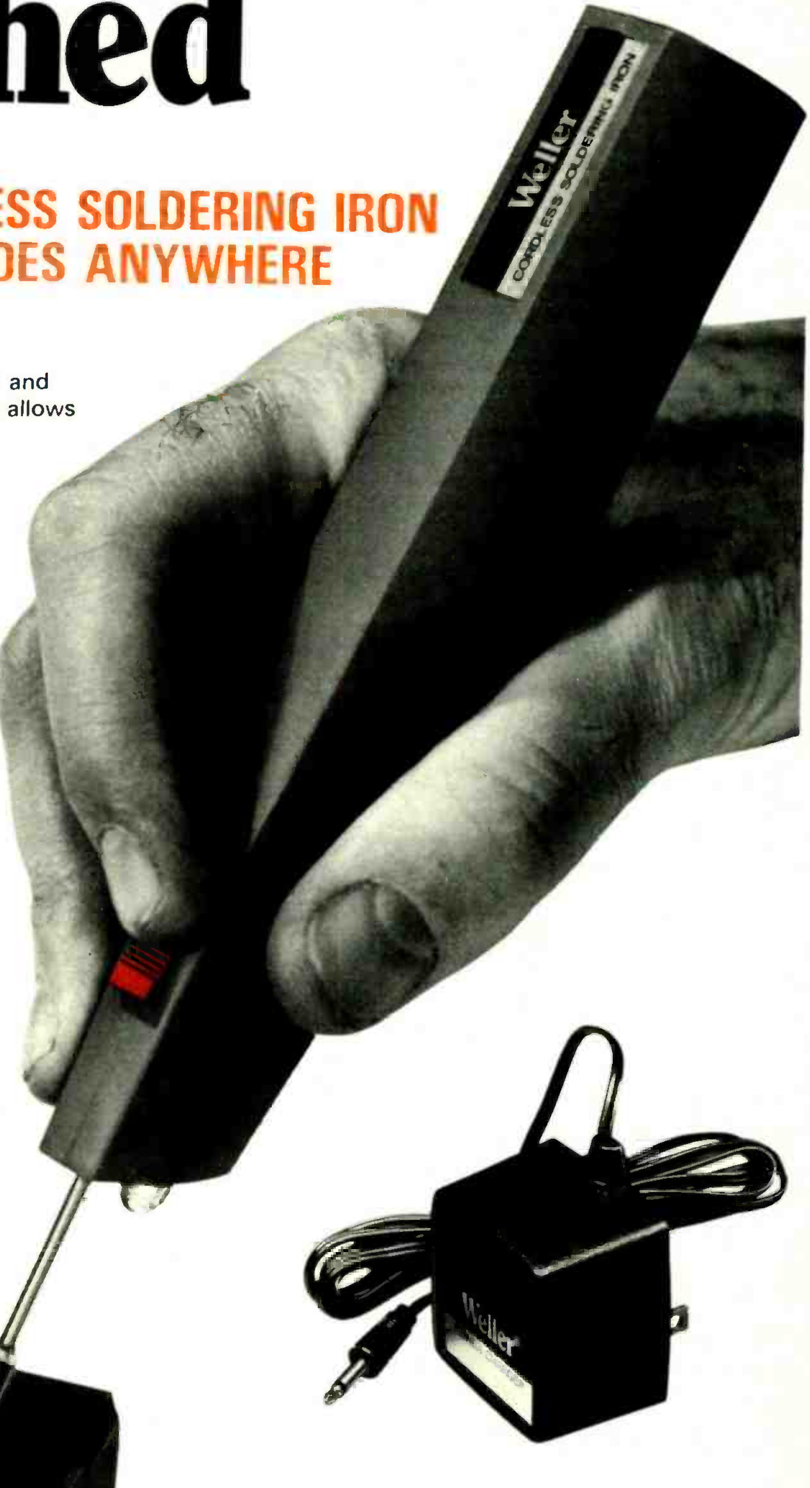
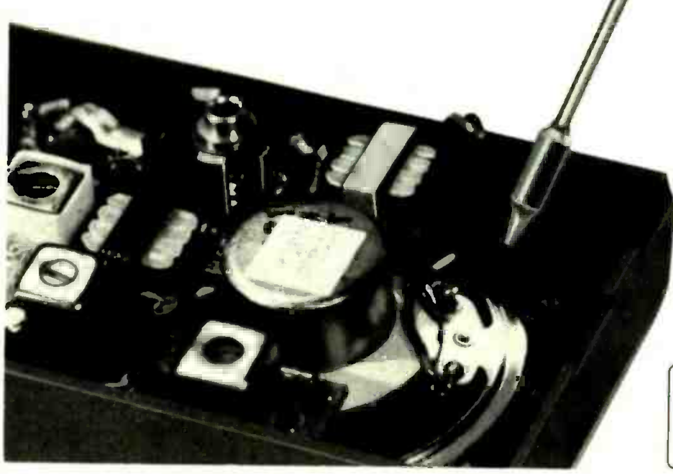


A professional quality tool, Weller's feather-light and fingertip-handy WC-100 Cordless Soldering Iron allows you to make connections anywhere...without dependence on an AC cord and outlet.

The heart of the WC-100 is its high-energy, long-life, nickel-cadmium battery which springs into action at the touch of your finger, heating the tip to over 700°F in just 6 seconds. And no danger of accidental discharge. Weller's exclusive sliding safety switch breaks the circuit when your finger is removed, won't lock in "on" position, and does lock in "off" position for added safety while restoring energy with fast-power recharger (UL listed).

Loosen two slotted set screws and you've got instant choice of four tips... regular, long-reach, fine-point, or miniature ...each mounted on an extra-strong stainless tube to resist bending. Tip is continuously illuminated by the built-in light which focuses on the work area, a special advantage under poor lighting conditions.

Try this for size! It's a full-scale photo of the compact WC-100. And the real thing is waiting for you at your dealer or distributor...right now. Need to know more? Request literature.



COOPER INDUSTRIES

Weller-Xcelite Electronics Division
The Cooper Group
P. O. BOX 728, APEX, NORTH CAROLINA 27502

Circle 6 on reader service card

letters

PERIPHERALS

With the rapid development of home-brew computer systems, the need for peripheral devices is sure to grow. Readers may be mystified about sources of paper-tape readers, card reader/punches, tape drives, etc. With the prices as they are, and the mechanical complexity of these devices, it may be cheaper to buy than build.

I thought other readers might be interested in a company that specializes in *used* computer equipment. Write to: American Used Computer Corporation, Post Office Box 68, Kenmore Station, Boston, MA 02215.

This company sells used micro (and macro) computers, central processors, memories, etc., in addition to peripherals. Since the equipment is used, the prices tend to be reasonable.

Keep the computer projects coming, they are fulfilling the dream of "a computer in every home."

STEVEN C. HORII
New York, NY

City of New York
Department of Consumer Affairs
80 Lafayette Street
New York, N.Y. 10013
Elinor Guggenheimer, Commissioner

Dear Ms. Guggenheimer:

Since you have taken office, it is obvious you have gone out of your way to make life unbearable for the hard working, law abiding citizen. The actions of your office in recent months, if allowed to continue, will cause mass bankruptcy and emigration from New York City of all types of independent service personnel.

To be more specific, I would like to call your attention to the havoc and mass hysteria you are inflicting upon the television service industry, of which I am a member. First, I would like you to explain why you singled out this industry for licensing, ignoring a multitude of others, equally deserving. If you really wanted to remove the rotten apples from the barrel (of each servicing field) and work for the public good (as you were appointed to do), you would have instituted similar licensing requirements for all industries which deal with the public. WHY HAVEN'T YOU?

Of course there are television repairmen who are dishonest and take advantage of the public. Licensing here may have cut down on the dishonest techniques of a select few, but due to excessive fees and an over-burdening of paperwork, you have forced most television service technicians to either raise their prices or go out of business. Is this

(continued on page 16)

Circle 8 on reader service card

LETTERS

(continued from page 14)

in the interest of the public good?

Suppose a customer takes me to court on fabricated charges. Assuming I am innocent and no conviction takes place, who compensates me for the time and income I lost as a result of being unable to work? Who protects me from members of the public (and there are many) whose hobby it is to take advantage of servicemen? THE POLICIES OF YOUR OFFICE ARE TOO ONE-SIDED! Why don't you introduce an amendment to current licensing regulations that would force the complainant to compensate the technician for his lost time and income if no criminal acts have been proven beyond doubt?

Your recent proposal that would allow the customer to sue the serviceman because he could not keep an appointment is sheer lunacy. If this becomes law, one of two things will take place. One possibility is that the large majority of independent servicemen will leave New York City, thus leaving the major service companies in control. I need not mention that their service rates are often more than twice those of many independents, but, as in the past, this should not interest you. Have you never heard of dishonest service procedures among the major companies? For your information, it is widespread. WHY HAVEN'T THEY BEEN LICENSED?

The other alternative is that the independent technicians will change their style of business from repairing the television receiver in the customer's house whenever possible to a pickup and delivery service. This will have to be done so as not to be late for appointments made hours or even days ago. Neither the technician nor the customer would like this arrangement. Prices will inevitably have to be raised because of the increased expense of transit.

First and foremost, you must keep in mind the fact that it is impossible for a service technician (especially television) to predict accurately how long a service call will take. It could be as short as fifteen minutes, or as long as five hours, depending on the difficulty of the repair (which is almost always unpredictable). Therefore, when a service technician prepares his daily schedule of appointments, he can only estimate the part of the day he will *probably* be at each customer's house (early or late afternoon, etc.). No matter how well planned a daily work schedule is, a longer stay than anticipated at the home of one or more customers due to unexpected repair problems encountered on one of the many highly inferior television receivers presently on the market can totally destroy the rest of the day's schedule.

In conclusion, therefore, I would like you to consider the aforementioned reasons and how they would make your recent proposal (allowing consumers to sue servicemen for missed appointments in the already overcrowded court system) impractical, unfeasible, UNBEARABLE, economically disastrous and just plain stupid. THERE IS NO NEED TO WAGE YOUR PERSONAL VENDETTA AGAINST SERVICE TECHNICIANS!! However, I am sure you will find that as you increase your attacks on the television and other service industries, you are only hurting the public, who you were appointed to protect. Service organizations will oppose you every step of the way with increased strength as you continue to rob the livelihood of their members. The majority of people in the television service industry (contrary to the picture you and your office have drawn) are honest and very hard working. The last thing they want to do is take advantage of the public, since respect and proper treatment of them keeps my fellow technicians and I in business.

JACK BERGER
JACK'S TV
Brooklyn, NY

COSMOS BURGLAR ALARMS

Regarding your article on COSMOS Burglar Alarms Part 1, appearing in the April issue of **Radio-Electronics**, I would like to see the following features added to your list of "requirements of the ideal burglar alarm."

The alarm should automatically reset after the Auto-Turnoff has occurred. If the alarm was falsely triggered, it would remain off after resetting. But if a door is left open, the alarm should reset after auto-turnoff and then trip again and remain on continuously until someone shuts off the power to the alarm or shuts the door.

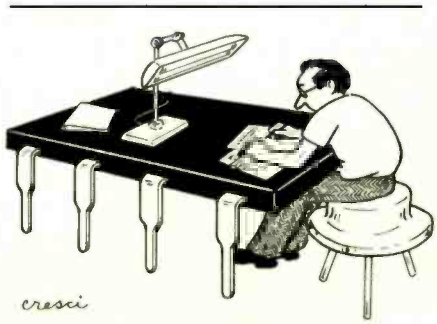
It should have a time-delay turn-on connected through one door to allow the user to set the alarm inside the home and have 20-30 seconds to exit. It should also have the same delay when returning to enter the home through the selected door without triggering the alarm.

The control and electronic alarm generator should operate from the same 12 VDC battery supply.

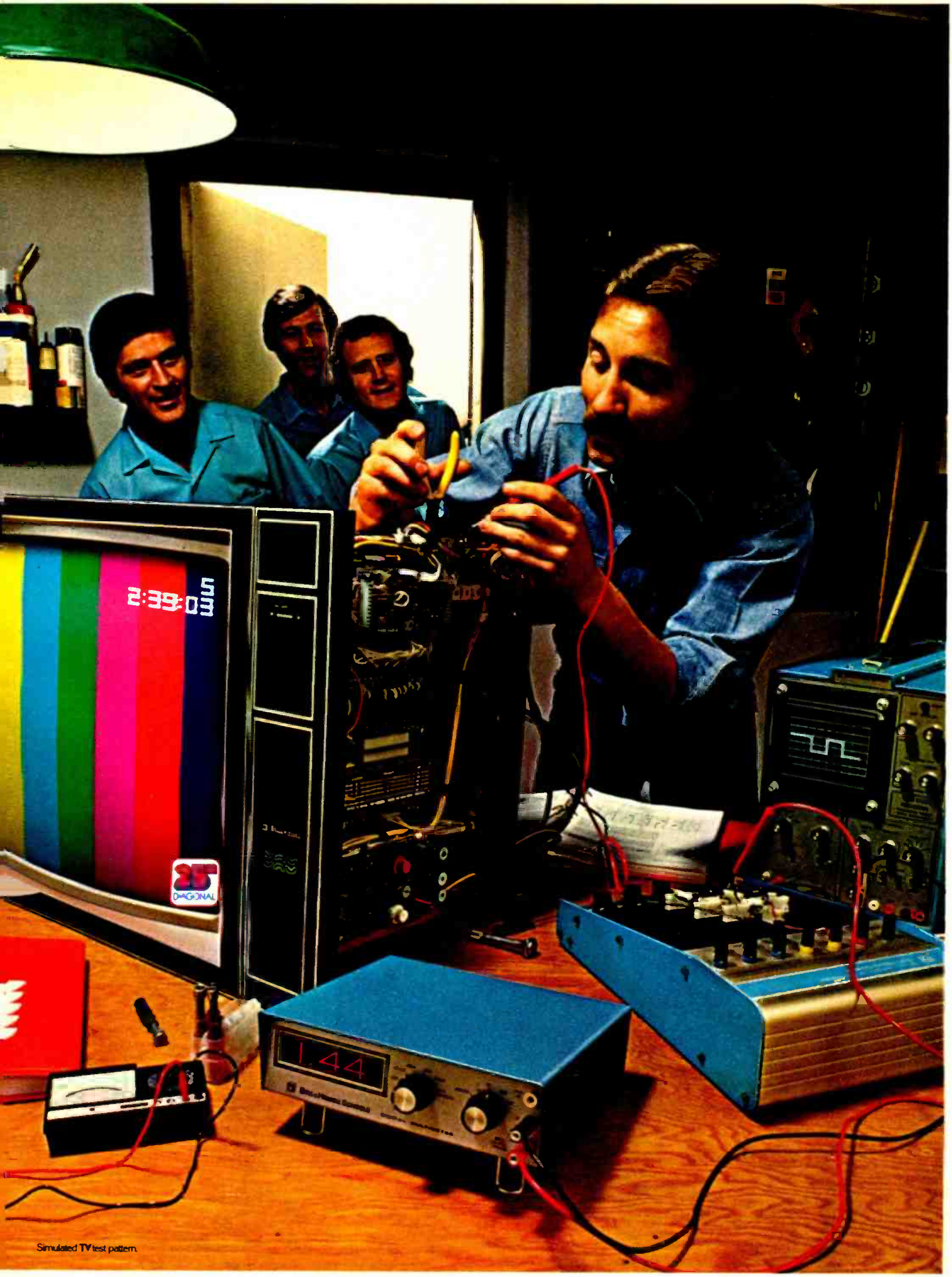
There should be a means of tripping both a 12 VDC electronic alarm generator and a 120 VAC circuit to turn on lights by use of solid-state electronics, such as solid-state relays using LED triggering, rather than mechanical relays. The battery powered alarm should be backed up by a 120 VAC combination 12 VDC, 4A regulated and filtered charger/eliminator to charge a gelled cell or nickel cadmium type battery.

If these features are included in the circuitry, you truly have the "ideal burglar alarm system."

DAVID BLUM
Philadelphia, PA **R-E**



Circle 10 on reader service card



Simulated TV test pattern.

equipment reports

B & K Model 520 Transistor Tester

Circle 107 on reader service card

THE B & K MODEL 520 IS AN INNOCENT-looking piece of test gear. Nice cabinet, dark panel with plain lettering, and three test leads with little blobs on the end. (Remember these blobs; they are something.) Inside the case, all kinds of things happen. This is a fully automatic transistor tester, in-circuit or out. Well, maybe not fully automatic; you do have to hook it up and turn it on. After that, things happen all by themselves.

The big problem in transistor testing has always been "Which connection is which?" These black beasts with three legs are all too often completely unidentified. To make a test, we must know which is which. The model 520 will tell you, and then test the transistor for the things we need to know. All you do is hook it up, and then move one switch. This will tell you whether it's good or not. Move another one, and it'll tell you what kind it is, and then read the leakage.

Those blobs are very special test leads. Each one has a tiny hook on the end, spring-loaded. The tips are so small that you can get into practically any transistor chassis and make connections to the leads. The hooks hold firmly, so that the rest of the job is "hands-off." For those chassis where they jammed the transistor tightly against the PC board, you can use the special probe with sharp pointed tips and get it from the wiring side.

The first test is for quality. All you have to do is move the TEST switch to each of its six positions. This changes the three connections around to every possible combination. The arrangement is shown by colored triangles, visible in a window on the panel. When you hit the right one, the 520 says "Beep!", and a LED on the panel lights up. This tells you that it's good and that it's either a PNP or NPN. No beep, no go; the transistor is either shorted or open.

This test can be made either in-circuit or out. The only time you'll have troubles in-circuit is in circuits where the transistor is shunted by a very small resistor or a big capacitor.

After this, leave the TEST switch in the correct position. Turning the FUNCTION switch to the left will tell you whether this transistor is silicon or germanium; two more LED's read this out. Turn the FUNCTION switch to the right, and it reads the leakage—I_{CES} or I_{BES} for bipolar transistors, and I_{DSS} for FET's. The meter scale is specially designed non-linear type, so that you can read a wide range of currents on a single scale.

There are four scales; small-signal silicon, power silicon, small-signal germanium and power germanium. The acceptable minimum leakage for each type is shown. Leakage in-circuit is not significant, due to shunting. Out-of-circuit leakage tests are definite. For out-of-circuit tests you can use the test leads or a socket on the panel.

The model 520 will test all bipolar transistors, including one that has been very hard to check—the Darlington-pair transistors in a single case. It will also check FET's, SCR's and diodes of any kind. Fine for matching diodes for AFC, etc.

For either in or out of circuit tests, you can identify the base arrangement of the transistor by looking at the little window. This shows the color of the lead connected to each element. This can be a very valuable feature, not only for transistor testing per se, but for identification of circuit test points that you need to know! The same test can be used to check diode rectifiers and detectors. It will identify the cathode lead on those unmarked diodes! This can be very handy. Video detector diode and similar types can be checked for leakage. This can cause a very fine "dog" symptom.

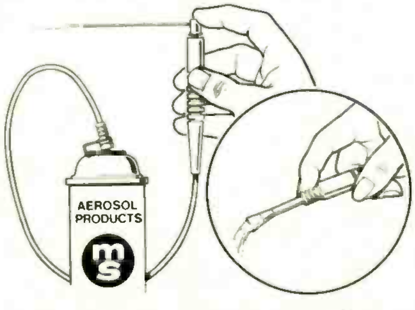
Quite by accident, I discovered another test. I was going through a small stereo amplifier, with a one-channel dead complaint. I hooked the 520 probes to an output transistor, and found that it would also check speakers! I could hear the "puttering" sound of the clock oscillator in the speaker. (Scared me for a minute!)

This one can turn out to be a real time-saver in any kind of solid-state work. Nowadays, that is definitely the name of the game. **R-E**

(continued on page 24)

EQUIPMENT REPORTS
(continued from page 22)

Miller-Stephenson Chem. Co. Products With Cobra Extension Nozzle



Circle 108 on reader service card

THE MILLER-STEPHENSON CHEMICAL CO. (Box 628, Danbury, CT 06810) has come up with some goodies for the TV-radio technicians, including one really ingenious, and very handy, new device. This company makes a long line of chemical compounds for industrial use, of all kinds, even "canned air" (for cleaning delicate instruments, etc.) and a static eliminator, *En-Stat*, plus a cleaner for plastics, metal and glass.

The goodies include *Contact Re-Nu*, a very effective contact cleaner. There is a magnetic head cleaner for all kinds of tape-heads—from computers down to 8-track stereo's. There is also a *Quik-Freeze* spray for those thermal intermittents, and a pure *Freon Degreaser* for cleaning up those filthy PC boards. There are others, including a flux-remover for PC boards that would be useful either in service or production work. This comes in two strengths—normal and heavy duty for those really dirty jobs.

The new device is their handy *Cobra* extension-nozzle kit. This has a small plastic tube, about 30 inches long, and a handle about the size of a felt-tip pen. A standard spray-nozzle with a 6-inch tube can be slipped over this. You hook it on the spray-can by pushing the coupler over the little metal pipe you see when you pull the nozzle that comes with the can off. Special latches hold it in place. To turn the *Cobra* on, just push it to one side and latch it.

To spray, just push the end of the *Cobra* handle to one side. The small size plus the long tubing makes it very easy to get into tight places in TV sets. I cleaned up a very dirty CONTRAST control in the tuner mounting assembly of an old set; it was so well concealed that I could barely *see* the thing.

For cleaning up spots on PC boards so that you can see your work, read color codes, etc., or for cleaning entire boards, there is a pure Freon Degreaser compound. This can be used with the *Cobra* extension nozzle. A special brush-handle can be plugged onto the *Cobra* handle. This is how; by pushing the handle, the solvent can be applied as needed while the brush loosens caked deposits and dirt. I cleaned up a couple of sets that were really dirty, and the boards looked like new. For cases where you suspect leakage across a board in a sensitive area, this is a dandy.

These products can be a real time-saver for the professional radio-TV and electronics man. They come in 16-ounce cans, which last a long time. They're available at many radio-TV supply houses, especially the Industrial Electronics suppliers. **R-E**

Heathkit IO-4530 10-MHz Triggered-Sweep Oscilloscope

Circle 100 on reader service card

IT'S TIME TO REPLACE YOUR VENERABLE but time-worn multi-tube oscilloscope with a more reliable solid state instrument. If your scope is devoted to TV servicing or other limited bandwidth lab work, the new Heathkit 4530 is a good candidate.

For $300 a single-trace 10-MHz 3-dB bandwidth scope can be assembled with good sensitivity and a choice of XY operation or calibrated, automatically triggered horizontal sweep. The 4530 has a device complement of 44 transistors, 22 diodes, and 9 integrated circuits.

The vertical or Y channel input feeds an attenuator with a parallel, 1 megohm-40pF input impedance. A series of ceramic trimmer capacitors compensate the attenuator over each decade of its 10mV/cm to 20 V/cm range. Following the attenuator, an FET source follower is used as the vertical amplifier input device. The high gate impedance of the follower prevents loading and inaccuracies of the input attenuator. There are a total of 11 vertical gain positions in a 1-2-5 sequence. DC coupling is used over the entire input level range. The AC coupling switch position rolls off the response 3 dB at 2 Hz.

The horizontal X amplifier has a 1-MHz 3-dB bandwidth with a sensitivity range of 0.02 to 2 V/cm in three decade steps. A compensated attenuator is also used in the horizontal channel with a similar 1 megohm-40 pF input impedance.

One of the strongest features of the 4530 is its modern triggered sweep. Trigger inputs are conditioned by filtering options and then switch a 741 op-amp discrete FET current source combination to generate an accurate linear sweep. A transistor switch discharges the time-base capacitor to ground during retrace, and the constant current source charges it negatively during trace. TTL 7400 gates and a 72710 voltage comparator are set up to trigger in the automatic mode at zero crossings of the sync input waveform. Trace scan begins on either the positive or negative slope of the sync waveform by inserting the right number of

(continued on page 26)

EQUIPMENT REPORTS
(continued from page 24)

inversions in the signal path. The sync can be derived from the vertical input channel, through the external trigger connector, or from the 60-Hz line from a tap on a power transformer winding.

Like its big brothers, in the automatic trigger mode the 4530 displays a base line in the absence of a trigger signal. If the trigger source is idle, the automatic baseline generator initiates sweep at a 40-Hz rate. To synchronize below 40 Hz, the trigger level switch is advanced from its detented position selecting the NORMAL sync mode. Auto-baseline circuitry is disabled and the trigger level is continuously variable over the range of −0.6 to +0.6 volts. As you might guess, these limits are determined by forward-biased silicon diode junctions. Sweep speed range is from 0.2 sec/cm to 200 ns/cm in seven decade steps. The 5X magnifier pull-out switch increases the gain of the horizontal amplifier five times by reducing the emitter resistance of the output differential cascode amplifier. DC, AC, and TV sync coupling is selected by a front panel switch. The TV position inserts an integration network to filter out the vertical sync. Video signals can then be locked in easily at a frame or field rate.

Regulated low voltage power supplies use a 4501 dual regulator IC for plus and minus 15 volts. Zener diodes drop these potentials to lower 5- and 12-volt sources for the TTL logic and comparators. The CRT voltages are all derived from a 1375-volt Zener stack.

Kit construction went smoothly. About half of twenty plus hours were spent putting together the main circuit board. It holds everything but the high voltage power supply and the front panel components. The three large vertical gain, horizontal gain, and sweep speed rotary switches are printed circuit types and mount directly on the main board without cluttered wiring. The low-capacitance switch inputs are brought out on non circuit board terminals so they can be routed to the input connectors by non-devious routes.

Separate assembly and operating manuals are included with extensive calibration and troubleshooting procedures. Detailed flow charts attempt to cover the majority of circuit problems. Our sample did not trigger horizontally when first completed. The trouble was traced to a defective holdoff monostable IC. A second fault impaired the retrace blanking. This problem was caused by an intermittent Zener diode. It is to Heath's credit that the only malfunctions in such a complex kit were due to two easily replaced components and not to a miswiring or a design related problem.

The scope appearance is quite professional and it is obvious it was meant to emulate well-known top drawer lab equipment. BNC connectors are used for the X, Y, and trigger inputs. An 8 × 10 cm graticule and CRT window cover the face of the 5 inch round CRT. About half of the four corner reticle squares are not scanned because of the tube shape. The CRT is surrounded by a substantial shield as well as mu-metal wrapping around the gun.

The IO-4530 measures 6.937 × 12.8 × 19.2 inches (17.7 × 32.5 × 49 cm) not including its detented dual-purpose carrying and support handle. It weighs 22.5 pounds (10.2 Kg). Power consumption is 65 watts from 120 or 240 volt nominal supplies.

The new Heath scope will be a welcome addition to the low budgeted service or circuit development organization by bringing a good deal of the feel of a high grade lab instrument within its grasp. It does not have the high brightness or VHF bandwidth of a $3000 Tektronix or Hewlett Packard scope, but it does have the same basic functional control philosophy with solid no-nonsense operating ease. I think Heath has been successful with the IO-4530 by providing the most instrument per dollar they know how. **R-E**

If you've ever said...

"There must be a better

Send for a free Career Guidance Booklet that could start you on the road to success in a rewarding new career.

It happens to all of us, sooner or later. No matter what kind of job we have.

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"Surely," we tell ourselves, "there must be a way to get more satisfaction out of working. Surely, there must be a way to find a job that's more rewarding."

"Surely," in other words, "there must be a better way to earn a living!"

If you, too, have been thinking these same thoughts, you'll find one of our free Career Guidance Booklets very helpful at this time. We invite you to send for one.

Your free booklet will describe the opportunities for higher income and greater job security you might expect in one of the career fields listed on card or coupon. It will also explain why ICS can prepare you for this new career field...right in your own home...in your spare time...regardless of your education or past experience.

Of course, no school—not even ICS—can guar-

We'll give you a treat if you pick up the tab.

This year—20 bonus tabs for color picture tubes.

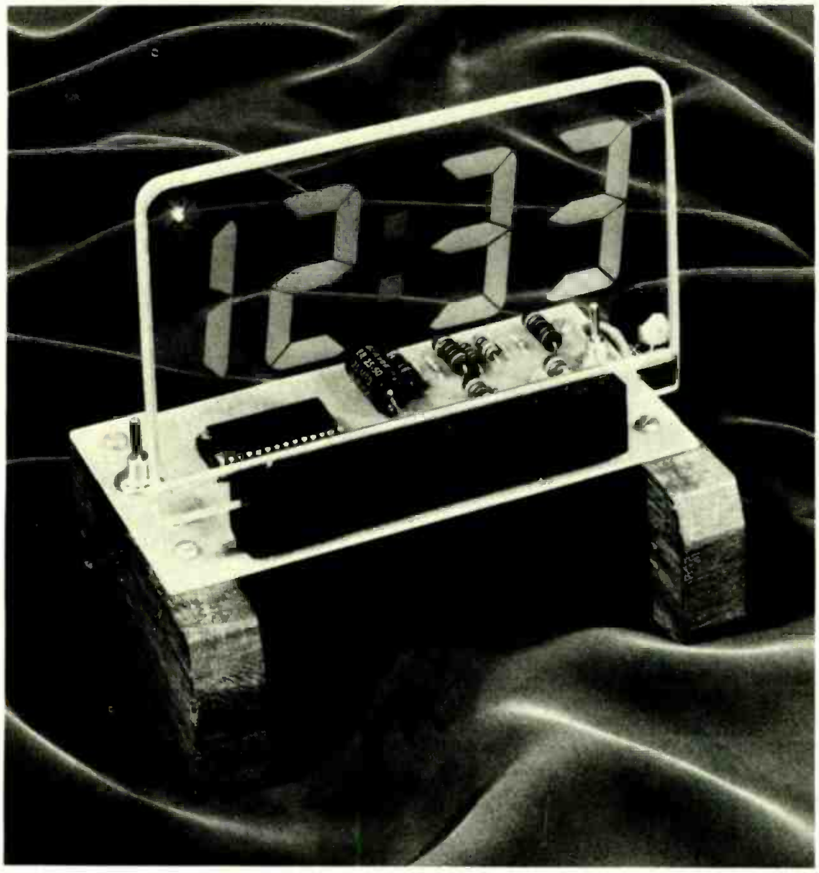
Sav-a-Tab '75 is now under way, so we hope you've been saving Sylvania tube box tabs all along—the tabs marked "WALTHAM" at the end of each box.

And this year we're adding a new dimension. One serial number label from a color-tube carton will earn you the equivalent of 20 receiving tube tabs. (You'll find the label on the upper left-hand corner of every color-tube carton.)

Sav-a-Tab '75 ends at midnight, Nov. 30, so get your catalog of treats right now. See your local Sylvania distributor or write Sylvania Award Headquarters, P.O. Box 1000, Fenton, Missouri 63026.

GTE SYLVANIA

Giant LCD Clock



Two-inch high numerals sandwiched between two clear glass panels makes this liquid crystal display a magical mystery and the clock a real conversation piece

by GEORGE J. WHALEN

BLACKSTONE AND HOUDINI, THE MASTER illusionists, would have been baffled by the high-technology legerdemain that makes the Magi-clock work! On a clear panel, transparent as a sheet of glass, the time of day mysteriously appears in two-inch high whitish numerals. Two digits accurately report the hours and two digits mark the passage of the minutes. Yet, there is no sign of wires or connections to the "floating" numerals! While the Magi-clock *tells* the time, it keeps the way it works a *secret*.

In just one enjoyable evening, you can assemble this extraordinary time-keeping conversation piece. Construction is made easy by the use of a single LSI integrated circuit, requiring but a handful of external components, and a large liquid crystal display that plugs into a mating connector on the printed circuit board. Powered directly from the AC line without bulky, heavy transformers, the Magi-clock is compact and light enough to build into any enclosure you can conceive of. And, its accuracy is as good as the closely-controlled 60-Hz power line frequency. The line frequency is held to +.02 Hz, −.05 Hz. Thus, the Magi-clock can deliver better than 0.1% accuracy over time periods up to an hour. Long time accuracy is maintained because accumulated cycles-per-second errors are periodically corrected by the power company.

The time-keeping heart of the Magi-clock is a type C1200 monolithic MOS integrated circuit manufactured by LSI Computer Systems, Inc. (see Fig. 1). Time set, logic, dividing for seconds, minutes, and hours, seven-segment decoding, and display drivers and switches, are all built into this unique "chip." Circuit functions use MOS p-channel enhancement and ion-implanted depletion mode devices.

The liquid-crystal display panel (LCD) is an optically-transparent "sandwich" that has many components that don't meet the eye at first glance. Figure 2-a reveals its inner secrets. Two glass panels (called front-plane and back-plane) make up the front and back of this device. The inner faces of the two panels are thin-film metallized with tin oxide or indium oxide. On one, the film has been deposited to produce the seven-segment patterns of the numerals, as well as a colon and starburst, together with thin-film metal conductors that lead down to a "connector" edge. Thus, each film-metallized segment is individually addressable (Fig. 2-b). The other glass panel is metallized over its entire inner surface.

The two metallized glass panels don't touch. They are separated by a normally transparent fluid called a *nematic liquid*.* A seal about the outer edge keeps the panels separated and prevents the liquid from leaking out. The assembled LCD appears to be transparent when not excited, since the metallizing film on the glass plates and the nematic liquid have about the same refraction index.

The LCD "sandwich" is a *field-effect device*. (Fig. 3.) Applying an electric field between the back metallized panel and any front metallized segment causes a molecular reorganization of the "crystalline" structure of the nematic liquid. Normally,

*An LCD's performance is based on the behavior of certain organic chemicals which simultaneously exhibit both liquid and crystal properties. These *nematic liquids* are transparent in the liquid state until their thread-like molecules are disturbed by the presence of an electrical field—a phenomenon discovered in 1888, but regarded as a laboratory curiosity until late in the 1950's when investigations of practical uses began.

these long, cigar-shaped molecules are in a parallel alignment and are free to slide past each other. In this unperturbed state, the crystal molecules don't scatter light, and so, the liquid appears transparent. However, when disturbed by an electric field, the well-ordered structure is upset; molecules organize randomly, thus scattering light passing through the LCD sandwich. This causes the affected area of the LCD to turn milky white. Thus, the LCD, when properly "addressed" by the output of the clock IC, provides an easily seen display of time by *scattering light*, rather than emitting light, as in other forms of digital readout devices.

The process of cycling the transmissivity of the crystals produces *dynamic scattering*, so that the LCD's light transmission properties at any instant depend upon the voltage applied between the front-plane and back-plane electrodes.

How it works

Components external to the clock IC are shown in Fig. 4. AC power is applied to a voltage divider (R1-R4), that supplies an 11-volt RMS 60-Hz count input to pin 22 of the IC, provides the input to a full-wave rectifier (D1-D4) and filter (C1) to supply DC operating potential to the IC, and supplies a nominal 40-volt RMS potential for excitation of the LCD segments, with transient over-voltage protection afforded by Zener diodes D5 and D6.

Referring now to Fig. 1 for events going on inside the IC; the 60-Hz line frequency signal goes from pin 22 to the TIMING CHAIN, where it is divided several times to generate binary coded decimal (BCD) equivalents of seconds, minutes and hours pulses that are fed to the SEVEN-SEGMENT MATRIX to be decoded. Outputs from the matrix go to the HIGH-VOLTAGE DRIVERS that control the ANALOG SWITCHES. The SEVEN-SEGMENT MATRIX is a complex decoder/driver. Here, the inputs from the timing chain, which are in the form of four BCD inputs for the first significant digit of the minute display, are decoded to excite the right number segments. For the second significant digit of the minute display, only three BCD inputs are needed, for here we are only counting from zero thru five, rather than from 0 to 9 as in the first significant digit. BCD outputs from the hours section of the timing chain are similarly decoded by the matrix.

The TIME SET GENERATOR receives a 2-Hz input from the TIMING CHAIN, and, depending on whether you close MINUTE SET switch S2 or HOUR SET switch S1, it generates a signal that advances the minutes or hours portion of the display at a 2-Hz rate.

The *carry inhibit* signal from the TIME SET GENERATOR serves a very important function. It makes sure that setting the minutes does not affect the hours display and vice versa. In other words, the minutes display goes to 00 after it reaches 59, but does not advance the hours setting. Simi-

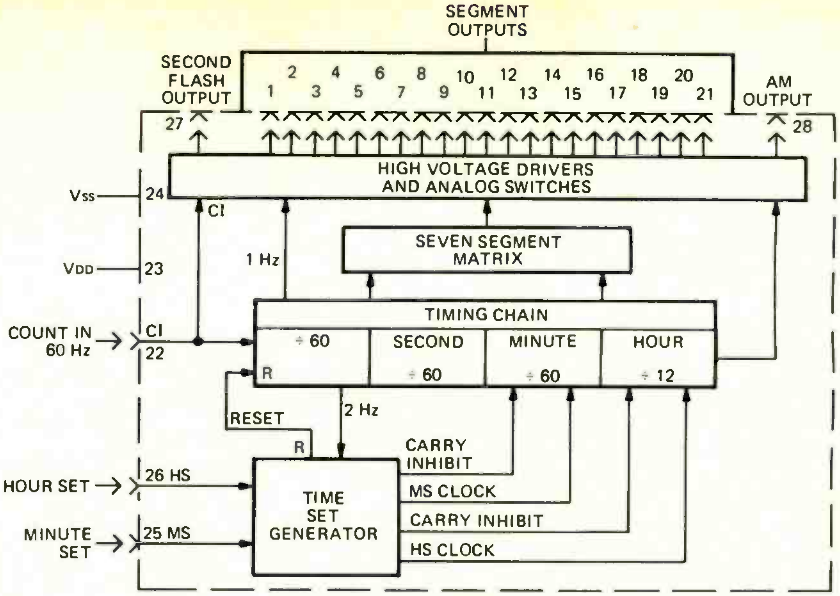


FIG. 1—BLOCK DIAGRAM of LSI Computer Systems Inc. C1200 clock IC.

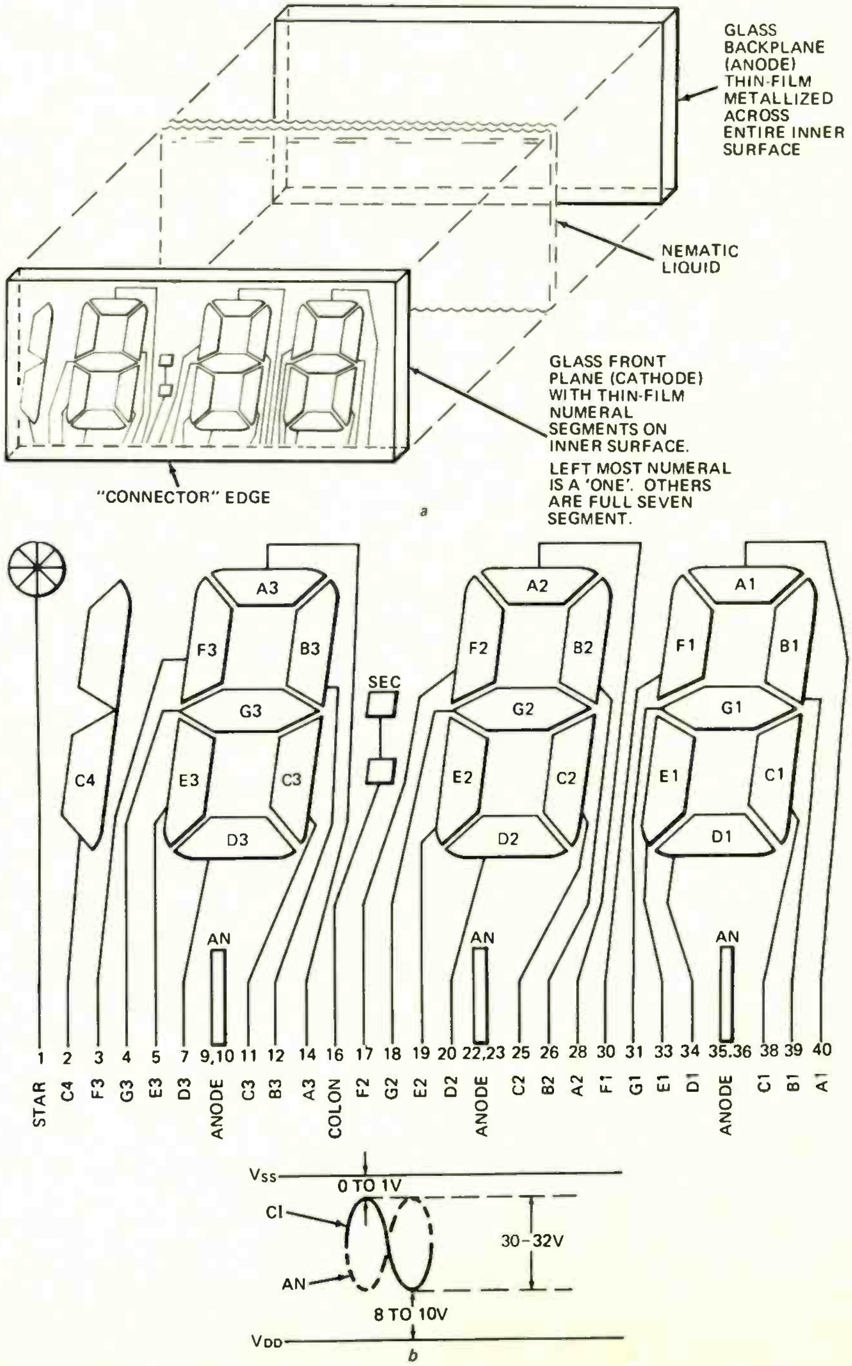
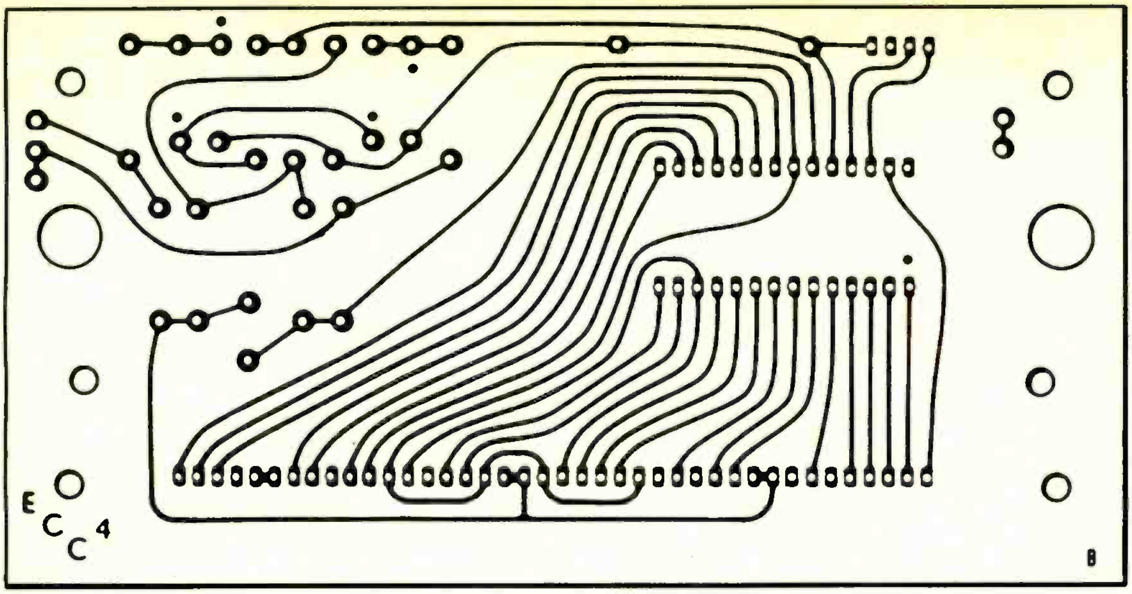
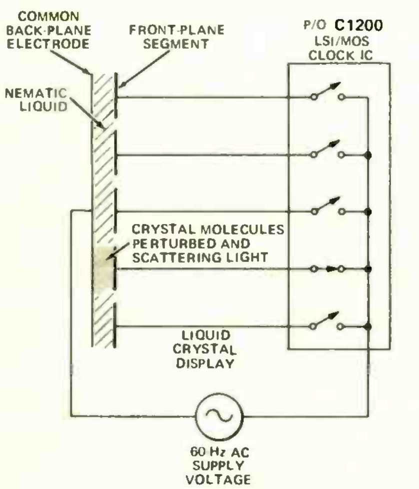


FIG. 2 (right)—CONSTRUCTION of liquid crystal display device is shown in a. Metallizing pattern and connections of liquid crystal display with diagram of voltages applied to the cathode (front-plane) and the anode (back-plane) is shown in b.



FOIL PATTERN for the printed circuit board shown full-size.



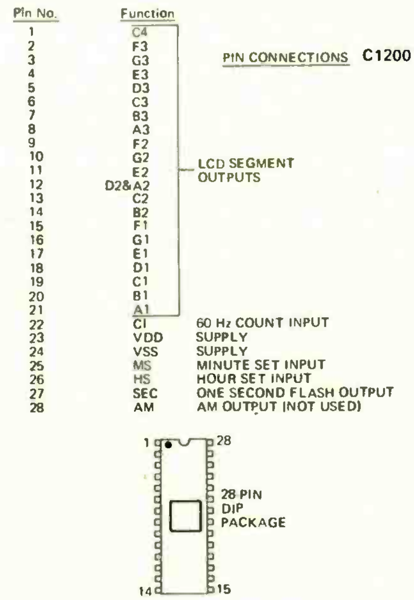


FIG. 3 (top)—THE CRYSTAL MOLECULES in the nematic liquid are disorganized by an electric field.
FIG. 5 (right)—PIN CONNECTIONS for LSI Computer Systems Inc. C1200 MOS clock IC.

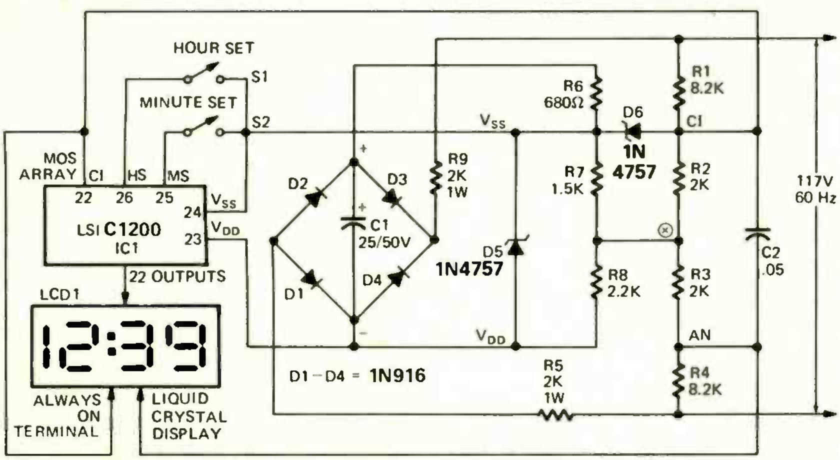


FIG. 4—SCHEMATIC DIAGRAM shows the C1200 IC and the external components necessary for the clock.

PARTS LIST

R1, R4—8200 ohms, ¼ W, 5%
R2, R3—2000 ohms, ¼ W, 5%
R5, R9—2000 ohms, 1 W, 5%
R6—680 ohms, ½ W, 5%
R7—1500 ohms, ½ W, 5%
R8—2200 ohms, ½ W, 5%
C1—25μF, 50 V, electrolytic
C2—.05 μF, 50 V, ceramic
D1, D2, D3, D4—1N916 or equal
*D5, *D6—Zener diode, 51V, 10%, 1W (1N4757 or equal) (Part MGC-51)
*IC1—C1200 (LSI MOS clock IC) (Part MGC-C1200)
S1, S2—spst, momentary contact (see text for details)
*LCD1—Liquid crystal display (Part MGC-50)
*Socket for display (Part MGC-116)
*28-pin IC socket (Part MGC-28)
*Circuit board (Part MGC-48-7)
AC line cord with plug

***These parts are available from Inventive Electronics, Box 53, Wykagyl Station, New Rochelle, NY 10804. Price of the partial kit containing all parts marked with an asterisk is $65 postpaid.**

larly, the seconds input to the minutes portion of the TIMING CHAIN has no effect when MINUTE SET switch S2 applies a signal to pin 25.

The *reset* output of the TIME SET GENERATOR is used when the IC is used as an elapsed time indicator. To do this, HOUR SET S1 and MINUTE SET S2 must be closed at the same time. This automatically generates a *reset* pulse which sets the timing chain—subseconds, seconds, minutes and hours—to zero. When both switches are released, simultaneously, the chip starts from an all-zero reference and counts "up", to add one minute to the time displayed every sixty seconds.

The cathode (front-plane) voltage input to the LCD goes through the ANALOG SWITCH that is ON at any given time so AC is applied to the appropriate segment of the LCD. The anode (back-plane) voltage is applied via three contacts on the display (see Fig. 2-b). Cathode and anode voltages are always 180° out of phase and identical in amplitude. There is *no* DC component present, for the life of an LCD is appreciably reduced if it is operated from a DC source, or from AC with a DC component. However, DC is required to perform the logic operations in the chip and is supplied from the full-wave supply consisting of low voltage diodes, D1, D2, D3, D4 and filter capacitor C1.

The two Zener diodes (D5, D6) are required for over-voltage protection of the IC. D5 limits the supply to 51 volts and D6 limits the voltage applied to the HOUR SET and MINUTE SET inputs (pins 26 and 25) to 51 volts, peak-to-peak. C2 acts as a high-frequency filter. It eliminates the high-frequency component of transients on the AC line. *(continued on page 92)*

1

Radio-Electronics® Tests Kenwood KR-5400

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THE KENWOOD MODEL KR-5400 2-CHANNEL receiver is a medium priced model in that company's broad line of stereophonic all-in-one receivers. The unit just above it in price and power (at 50 watts continuous power-per-channel) is their model KR-6400, which costs $70 more. The next lowest unit in power and price would be the KR-4400, with an output of 25 watts-per-channel and a retail price of $299.95. At its price, the KR-5400 offers a variety of control features that should appeal to the serious audiophile who requires this amount of power in an all-in-one receiver.

The Kenwood model KR-5400 is shown in Fig. 1. The upper section of the panel has a long, blacked-out dial scale area which becomes illuminated in soft blue when power is applied. The signal-strength meter, located at the upper right of this area is only illuminated when AM or FM reception is selected, and the dial pointer itself becomes illuminated in red when radio reception is selected by means of the program selector switch. The FM and AM dial scales are well calibrated with notations at every 2 MHz for the perfectly linear FM dial scale and a reference logging scale located below the AM and FM scales. To the right of the dial scales are the large tuning knob coupled to an effective flywheel tuning system, and a dual concentric master volume and balance control. The balance control section of this dual control takes the form of a lever that can be swung to favor left or right channel output. A mechanical detent helps establish its center position. This lever tends to be hidden because of the color scheme of the panel and its position under the master volume control and the user who fails to read the owner's manual might well wonder, at first, if balancing facilities were overlooked entirely.

The lower section of the gold colored aluminum panel has a rugged looking lever-type power on off switch at the left. This is followed by a six-position speaker selector switch (which includes an off position for headphone listening as well as choices for any one of three pairs of speakers which can be connected to the receiver or combinations of main and either remote pair of speakers operating together), separate bass and treble tone controls, a mode switch (with settings for left, right, stereo, reverse and mono-mix), a program selector switch and six push buttons. The buttons are used to actuate either of the two tape monitor circuits, FM muting, low-and high-cut filters and loudness circuitry. Along the lower edge of the panel there is the usual headphone connection jack as well as a microphone input jack. Only a single microphone can be connected to the receiver and its signal will be reproduced monophonically through both speakers.

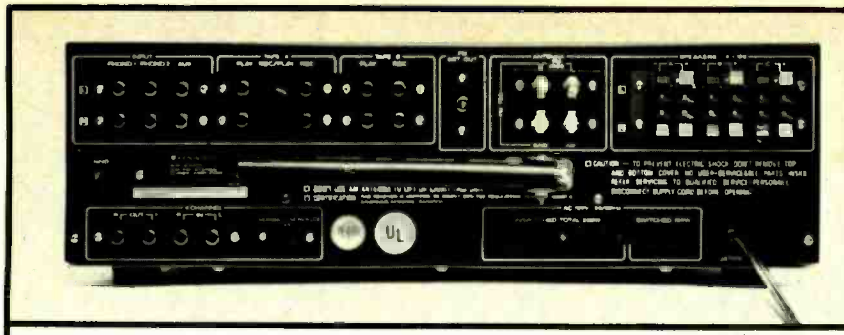
The cabinetry of the KR-5400 consists of a pair of walnut side panels mounted to a metal enclosure, the top surface is well ventilated with slots. The rear panel of the receiver is shown in Fig. 2, and a diagram illustrating all the various components which can be used with the unit and how they are connected is shown in Fig. 3. The rear panel is equipped with the usual input and output jacks (two turntables can be connected), antenna terminals for FM and AM external antennas, an FM detector output jack (for future use with FM four-channel adaptors), in and out jacks for the

TABLE I
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **Kenwood** Model **#KR-5400**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF sensitivity, Mono: (μV)	3.0	acceptable
Sensitivity, Stereo (μV)	16.0	acceptable
50 dB quieting signal, Mono (μV)	4.0	very good
50 dB quieting signal, Stereo (μV)	35.0	good
Maximum S/N ratio, Mono (dB)	69	very good
Maximum S/N ratio, Stereo (dB)	59	good
Capture ratio (dB)	1.5	very good
AM suppression (dB)	65	excellent
Image rejection (dB)	72	very good
IF rejection (dB)	90	excellent
Spurious rejection (dB)	85	excellent
Alternate channel selectivity (dB)	63	very good
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50Hz to 15 kHz (±dB)	+0, –2.0	good
Harmonic distortion, 1kHz, Mono (%)	0.1	excellent
Harmonic distortion, 1kHz, Stereo (%)	0.2	excellent
Harmonic distortion, 100 Hz, Mono (%)	0.07	excellent
Harmonic distortion, 100 Hz, Stereo (%)	0.45	good
Harmonic distortion, 6 kHz, Mono (%)	0.20	very good
Harmonic distortion, 6 kHz, Stereo (%)	2.0	acceptable
Distortion at 50 dB quieting, Mono (%)	1.75	good
Distortion at 50 dB quieting, Stereo (%)	0.40	excellent
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV)	16.0	acceptable
Separation, 1 kHz (dB)	44	excellent
Separation, 100 Hz (dB)	35	excellent
Separation, 10 kHz (dB)	33	excellent
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV)	20	acceptable
Dial calibration accuracy (±kHz @ MHz)	200	acceptable
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		very good
Ease of tuning		good
Accuracy of meters or other tuning aids		good
Usefulness of other controls		very good
Construction and internal layout		good
Ease of servicing		good
Evaluation of extra features, if any		good
OVERALL FM PERFORMANCE RATING		good



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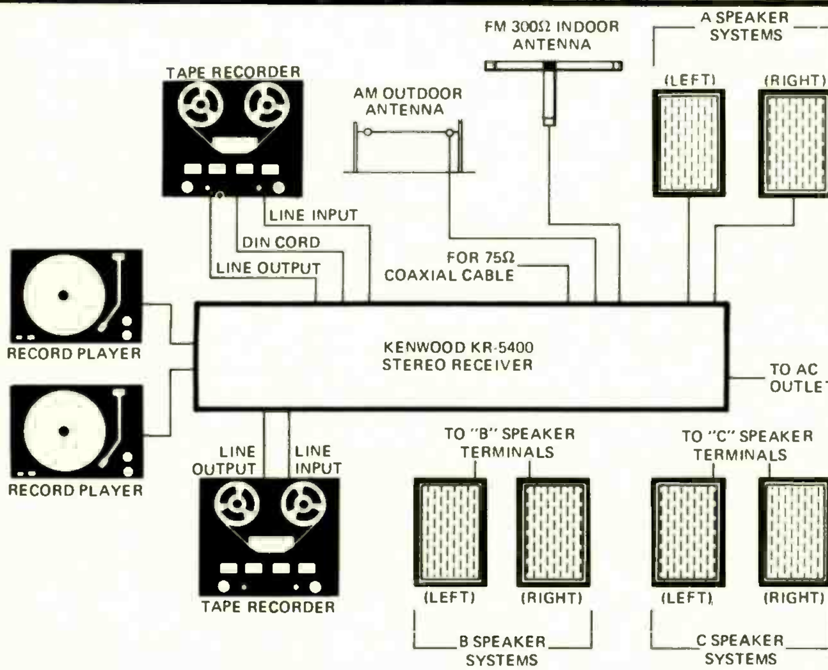

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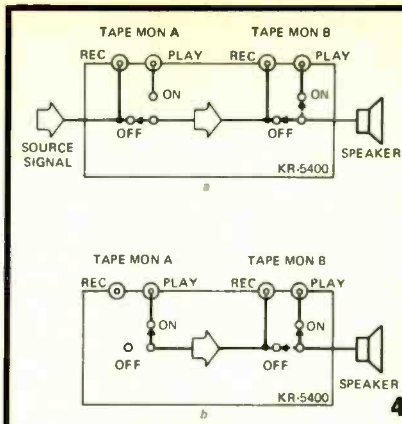

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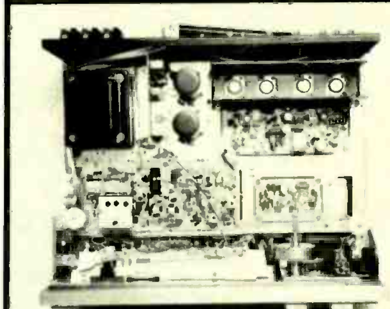

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Kenwood KR-5400 Stereophonic AM/FM Receiver

SUMMARY OF MANUFACTURER'S PUBLISHED SPECIFICATIONS:

TUNER SECTION (FM)
IHF Sensitivity: 1.9 μV. **S/N Ratio:** 68 dB. **Quieting Slope:** 48 dB at 4 μV; 60 dB at 10 μV; 68 dB at 50 μV. **Selectivity:** 65 dB. **Capture Ratio:** 1.5 dB. **Image Rejection:** 70 dB. **IF Rejection:** 90 dB. **Spurious Rejection:** 90 dB. **Harmonic Distortion:** (mono): 0.3%; (Stereo): 0.5%. **Stereo FM Separation:** (1kHz): 35 dB; (10 kHz): 27 dB.

TUNER SECTION (AM)
Sensitivity: (ext. antenna): 18 μV. **Selectivity:** 30 dB. **Image Rejection:** 60 dB. **IF Rejection:** 40 dB. **S/N Ratio:** 45 dB.

AUDIO AMPLIFIER SECTION
Continuous Power Output: (Both channels driven, 8 ohm loads, 20 Hz to 20 kHz): 35 watts-per-channel. **Rated Harmonic Distortion:** 0.5%. **Rated IM Distortion:** 0.5%. **Frequency Response:** 10 Hz to 40,000 Hz$\pm$1 dB. **Phono Equalization:** RIAA $\pm$ 1 dB. **Damping Factor:** 50 (at 8 ohms). **Input Sensitivity:** (Phono): 2.5 mV; (Aux & Tape): 150 mV. **Record Output Level:** 150 mV. **Hum and Noise:** (Phono 1 & 2): 70 dB ("A" Weighting); (High Level Inputs): 90 dB ("A" Weighting). **Tone Control Range:** (Bass): $\pm$10 dB @ 100 Hz; **(Treble):** $\pm$10 db $\pm$ 10 kHz. **Low Filter:** —5 dB @ 100 Hz. **High Filter:** —10 dB @ 10 kHz.

GENERAL SPECIFICATIONS
Power Requirements: 120 V, 50/60 Hz, 240 watts maximum consumption. **Dimensions:** 18-15/16 $\times$ 5-15/16 high $\times$ 13-9/16 deep. **Weight:** 25.4 lbs. **Retail Price:** $379.95.

two tape monitor circuits (as well as a DIN connector for one of those monitoring circuits) and two unswitched plus one switched AC convenience receptacles. Speaker terminals for three possible pairs of speakers are of the spring-loaded piano key type that require only the simple insertion of stripped wire ends into a tiny hole that appears when the terminal keys are depressed.

Four additional jacks at the lower left of the rear panel are labelled 4-CHANNEL IN and OUT. They are, in reality, the components of a third tape monitor circuit and permit the user to introduce a 4-channel matrix decoder without giving up either of the other two front-panel actuated tape monitor circuits. To use this facility, it is necessary to move a rear panel slide switch to the position identified as "separate". This circuit interruption should not be confused with the preamp-amp separating switches which are supplied on some costlier receivers. The circuit separation in this case occurs ahead of all tone control and volume or balance control action, whereas the preamp-amp arrangements on some receivers actually occur after all preamplification and control functions have taken place.

The two tape monitoring circuits of the Kenwood KR-5400 provide a high degree of versatility for the serious recordists. You can record any program source onto one or two tape recorders simultaneously (See Fig. 4A) or you can dub from one tape recorder to another (See Fig. 4B) and monitor recorded results on the second recorder. When recording to two recorders at once, only the recorder connected to the "Tape Mon B" jacks can be simultaneously monitored.

Circuit configuration and features

An internal view of the chassis of the KR-5400 is shown in Fig. 5. Eight separate circuit modules are used in its construction, of which three major ones can be seen in the photograph. The entire FM tuner circuitry is contained on one large PC board. This circuit contains the front end, which consists of an FET RF amplifier plus two conventional transistors used as local oscillator and mixer circuits. Tuning is by means of a three-gang variable capacitor. A two-gang capacitor is used for AM tuning and bi-polar discrete transistors are used for the AM front-end circuitry. Some of the IF FM section is shared by the AM IF circuits, and a total of four bipolar transistors followed by an IC and a conventional ratio detector are used in this section. All but one stage of the IF section are tuned by means of conventional interstage transformers. The multiplex stereo decoder consists essentially of a single IC circuit which includes a phase-locked-loop arrangement and requires no adjustable tuned circuits for optimizing separation.

Phono and microphone preamplification

is accomplished by IC's on a separate well shielded module, with equalization selectable depending upon the setting of the program selector switch. Thus, microphone use, besides being limited to monophonic reproduction, cannot be "mixed" with any other program source. Tone control circuits also use IC's (one for each channel) and are of the popular negative feedback type. Both power amplifier circuits are mounted on a single PC board which includes the output transistors (complementary-symmetry NPN-PNP pairs) that mount through a single large heat sink directly to the PC board itself. Input stages are differential amplifiers and each power amplifier is completely direct coupled.

FM tuner measurements

Results of our FM performance measurements are tabulated in Table I, and readers can compare measured results with manufacturer's published claims, where applicable. Although IHF sensitivity fell short of the 1.9 μV claimed, we cannot fault tuner performance on this score, since with only 4 μV applied, S/N ratio reached an acceptable 50 dB. We were also rather surprised at the better than average selectivity measured for this tuner that, after all, uses a "bare minimum" three-gang tuning capacitor and a not terribly sophisticated IF design. What did disturb us somewhat was the rather high level of sub-carrier product output from the stereo FM section, which was only about 45 dB below full modulation. Kenwood claims carrier suppression of 60 dB. Of course, this high frequency output is not audible, nor will it adversely affect tweeters (the energy is too low), but it may cause some problems with tape recorders having lower than usual bias frequencies. While stereo separation was excellent, the presence of "beats" when attempting to measure THD at high audio frequencies in the stereo mode resulted in the rather high 2.0% reading shown in Table I.

Amplifier performance measurements

Amplifier measurements are tabulated in Table II. Specifications quoted by Kenwood are in complete compliance with the new FTC rules on power disclosure, and these numbers more than met in our individual measurements. Had Kenwood wanted to be a bit less conservative, they could well have elected to rate the power output of each channel at 37 watts instead of 35 and still met FCC requirements. In fact, in just about all respects, the amplifier section of the KR-5400 rates a bit better than the tuner section. The only criticism we might levy against the unit is in its equalization characteristics, which departed from correct RIAA values by as much as 3 dB at the low end, providing more bass boost at 50 Hz and 30 Hz than is called for. Slight counterclockwise rotation of the bass control easily rectifies this discrepancy. if phono reproduction seems excessively bassy to you.

Since Kenwood elected to quote hum-and-noise figures using an "A" weighting network (which takes into account the audibility factor of hum-and-noise), we did likewise and came up with 72 dB as opposed to the 70 dB claimed. Even without this correcting network, the phono hum measured a very high 65 dB referred to full output and based on the 2.5 mV input sensitivity.

Tone control range is plotted in Fig. 6 and is typical of this type of circuitry. Action of the low- and high-cut filters is plotted in Fig. 7 and, while the choice of cut-off and slope of the low filter helps to correct for rumble problems without seriously affecting musical bass response, the same is not true of the treble cut filter which does little more than duplicate the action available from the regular treble control.

Utilization and listening tests

As is true of all honestly designed power amplifiers, the Kenwood KR-5400 "sounds" more powerful that it really is. We had no trouble driving low-efficiency acoustic supension speaker systems to 100 dB sound-pressure-level in our 14 × 21 foot listening room. Action of all controls is smooth and there is no turn-on popping noise, thanks to a relay which is included in the protection circuitry of the receiver that delays application of audio signals to the speakers for a few seconds after turn-on.

FM reception was good, at least in our location, using a 5-element outdoor antenna. The signal-strength meter is not of great help in proper tuning (a center-of-

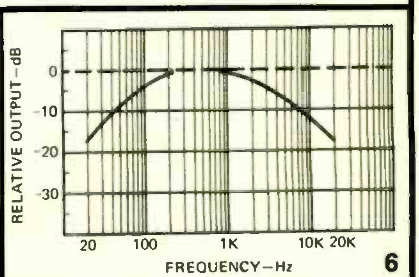
TABLE II

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer **Kenwood** Model **#KR-5400**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	39	good
RMS power/channel, 8-ohms, 20 Hz (watts)	37	excellent
RMS power/channel, 8-ohms, 20 kHz (watts)	38	very good
RMS power/channel, 4-ohms, 1 kHz (watts)	50	very good
RMS power/channel, 4-ohms, 20 Hz (watts)	45	very good
RMS power/channel, 4-ohms, 20 kHz (watts)	49	very good
Frequency limits for rated output (Hz-kHz)	18-23	excellent
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.14	very good
Intermodulation distortion, rated output (%)	0.55	good
Harmonic distortion at 1 watt output, 1 kHz (%)	0.10	good
Intermodulation distortion at 1 watt output (%)	0.05	excellent
DAMPING FACTOR, AT 8 OHMS	50	excellent
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA ± ___ dB)	3.0	acceptable
Maximum input before overload (mV)	135	very good
Hum/noise referred to full output (dB) (at rated input sensitivity)	72	excellent
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, ± ___ dB)	10-40, 1	excellent
Hum/noise referred to full output (dB)	87	excellent
Residual hum/noise (min. volume) (dB)	90	very good
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 6	good
Action of secondary tone controls		....
Action of low frequency filter(s)	See Fig. 7	good
Action of high frequency filter(s)	See Fig. 7	acceptable
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.5/2.5	
Input sensitivity, auxiliary inpu (s) (mV)	143	
Input sensitivity, tape input(s) (mV)	143	
Output level, tape output(s) (mV)	143	
Output level, headphone jack(s) (V or mW)	N/A	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		very good
Adequacy of input facilities		excellent
Arrangement of controls (panel layout)		very good
Action of controls and switches		very good
Design and construction		good
Ease of servicing		very good
OVERALL AMPLIFIER PERFORMANCE RATING		very good



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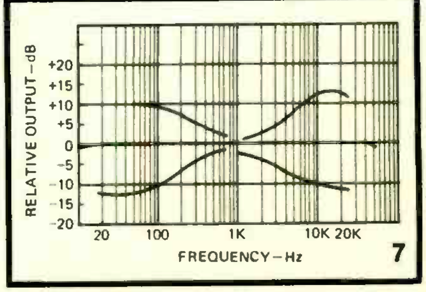

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TABLE III

RADIO-ELECTRONICS PRODUCT TEST REPORT

OVERALL PRODUCT ANALYSIS

Manufacturer Kenwood	Model #KR-5400
Retail Price	$379.95
Price Category	Medium
Price/Performance Ratio	very good
Styling and Appearance	excellent
Sound Quality	very good
Mechanical Performance	good

Comments:

The amplifier performance of the Kenwood KR-5400 merits a higher rating than does the tuner performance of this receiver. Its power output capability (for this price category) is high, and adequate reserve power is available at the important low-frequency extremes. High cut filter action is no more useful than the treble control, however, because of its low turnover point and its minimal 6 dB/octave slope.

Given the option of only one tuning meter, we would have preferred to see a center-of-channel meter for FM tuning. Tuning feel, however, is very smooth and in typical moderate to strong signal locations, FM performance will be adequate, despite the rather sparse front-end design and the use of conventional interstage tuned transformers in the IF section. The stereo multiplex section is extremely stable and separation was excellent, though the presence of high amounts of sub-carrier products in the output may create problems when taping FM programs on some recorders. We recommend using the high-cut filter for such taping operations if audible "beats" are encountered in completed recordings. The phase-lock-loop circuit used in the stereo MPX section will insure continued stable separation and no alignment should be necessary for this section. The FM IF section may need periodic alignment, however.

The linear FM dial scale (present on all Kenwood receivers and tuners) is a welcome feature and makes station finding easier.

Compared to some phono preamp IC's we have tested in other receivers, the one used in the KR-5400 has excellent overload capabilities and, with the low residual phono hum measured, record reproduction will have adequate, if not superb, dynamic range. The slightly exaggerated bass equalization can be compensated for by a slight bass-cut setting on the bass control. In summary, an excellent amp-preamp section plus an adequate tuner.

channel meter would have been preferred), but tuning is nevertheless relatively easy and bandwidth seems great enough so that the lowest distortion settings are consistently obtained without using any auxiliary equipment as a check. Calibration was off by about 200 kHz at the low end of the dial, but right on target from about 94 MHz up to 108 MHz. Stereo switching occurs at about the right signal strength, though muting threshold is adjusted a bit too high for our taste. By not using the muting feature we were able to receive about three additional stations with acceptable quieting that would otherwise have been blocked by the muting circuit.

Our capsule summary, along with overall comments, is tabulated in Table III. No unusual heat problems were encountered while operating the Kenwood KR-5400 for extended time periods and it passed its FTC pre-conditioning tests easily. While lacking some of the circuit sophistication of more expensive receivers, the Kenwood performed well in its price category and compares very favorably with competitive units in that same price range. **R-E**

Radio-Electronics® Tests Crown VFX-2

1

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

AUDIO PERFECTIONISTS HAVE LONG RECOGnized the virtues of bi-amplification and tri-amplification in high fidelity sound reproducing systems. For the uninitiated, bi-amplification means using two separate amplifiers to drive the woofer and tweeter of a loudspeaker system, or as many as three or four power amplifiers if three- and four-way speaker systems are used. By doing away with the usual passive crossover network normally included with multi-driver speaker systems, certain problems of phase distortion and IM distortion are often eliminated and, in many cases, a better balance between low-, mid- and high-frequency sonic energy can be created in the listening room.

In addition to requiring two or more stereo amplifiers for such an arrangement, an electronic crossover must be used. This device channels required bands of audio frequencies to the respective amplifiers and, in some cases, adjusts the level of signals going to each amplifier. One such product is Crown's Model VFX-2, shown in Fig. 1. It contains enough circuitry for a bi-amplification two-channel system and can be interconnected to provide tri-amplification facilities for a single audio channel. So, if you plan to use three-way speaker systems with an electronic crossover (and three power amplifiers per channel), two of these Crown units would be required for stereo reproduction. Figure 2 shows how the device would be interconnected in a two-way speaker system set-up. Figure 3 shows a single channel of amplification connected to feed a three-way speaker system.

The front panel of the VFX-2 contains eight rotary controls; four for each stereo channel. A selector switch either removes a given filter from the circuit (in its "off" position) or chooses a frequency multiplication factor of × 10, × 100 or × 1000. Adjacent to each selector switch is a rotary control calibrated from 2 to 20. Thus, low- and high-pass corner frequencies (frequencies at which response is down 3 dB) can be adjusted from 20 Hz to 20,000 Hz.

As a a first experiment, we adjusted the low- and high-pass controls of channel-one so that the corner frequencies coincided at 1000 Hz and plotted the response from the output jacks labelled LOW PASS OUTPUT and HIGH PASS OUTPUT. The frequency response observed at each output are combined in the graph shown in Fig. 4.

While this is perhaps the most popular application of the VFX-2, it can also be used as an audio bandpass filter, thanks to a novel switching arrangement available on the rear panel (see Fig. 5). The rear panel includes a pair of balanced or unbalanced inputs at the right, with adjacent screwdriver controls which permit adjustment from unity gain to +15.5 dB and a pair of unity gain inputs (with no gain adjustments). There are pairs of normal and inverted high-pass output and pairs of normal and inverted switchable outputs that, depending upon the setting of the pair of adjacent slide switches, provide either a low-pass output or bandpass output.

The reason for the normal or inverted output becomes clear when you consider that the power amplifiers used with the system may or may not have equal numbers of phase-inverting amplifier stages. If the number is unequal, then applying in-phase signals to the bass and treble amplifiers in a bi-amplified system would result in out-of-phase outputs to the speakers. By providing normal and inverted outputs on the VFX-2, this problem is easily solved.

Additional possible response curves and applications, together with front panel control settings and rear panel required connections and switch positions are illustrated in Fig. 6.

Circuit Description

The Crown VFX-2 Electronic Filter/Crossover consists primarily of two identical channels of active IC operational amplifier tunable filters. A schematic of one of the channels is shown in Fig. 7. Operational amplifier IC1-a, functions as a balanced gain amplifier. The unity-gain output of IC1-b is applied to the input circuit of IC2-a (high-pass filter) only or to that circuit plus the input circuit of IC4-a (low-pass filter) depending upon the position of the crossover-filter switch. The output from IC1-b can also go directly to

SUMMARY OF MANUFACTURER'S PUBLISHED SPECIFICATIONS

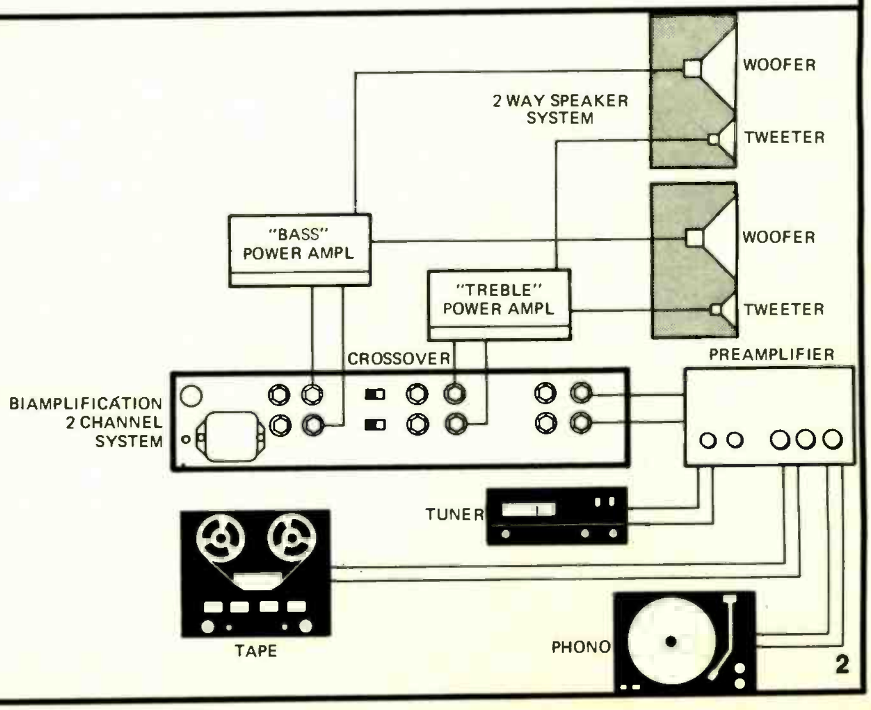
Frequency Response: 18 Hz to 38 kHz ±0.5-dB into 600-ohm load.
Inputs: Bridging input, 20K ohm balanced or 10K ohm unbalanced, and 1M ohm unbalanced; both using ¼ in. standard phone jack.
Output: 10 volts maximum before overload; 2.5 volts rated.
Gain: 0 to 15.5 dB from balanced/unbalanced input.
Hum and Noise: More than 100-dB below rated output, with 0-dB gain, over entire audio spectrum from 20 Hz to 20 kHz.
IM Distortion: Less than 0.01% at rated output
Filter Characteristics: Separate 18-dB Butterworth highpass and lowpass, with adjustable corner frequencies. Can be internally cascaded to form band pass and band reject filters.
Controls: (front panel) Range and vernier controls for corner frequencies (high and low pass), power on/off switch. (rear panel): Screwdriver-adjustable input attenuators for each channel.
Dimensions: 19-in. wide (standard rack mount) × 3½-in. high × 5¾-in. deep.
Power Requirements: 2 watts at 120 or 240 VAC, 50-400 Hz.
Weight: 6 lbs. Retail Price: $249.00

RADIO-ELECTRONICS PRODUCT TEST REPORT
OVERALL PRODUCT ANALYSIS

Manufacturer **Crown International** Model **#VFX-2**

Retail Price	**$249.00**
Price Category	**Medium**
Price/Performance Ratio	**Good**
Styling and Appearance	**Excellent**
Sound Quality	**Excellent**
Mechanical Performance	**Good**

Comments: As might be expected, based on the dynamic range capabilities and low distortion measurements made, the VFX-2 introduces no audible distortion or noise of any kind. We would have liked to see some sort of level controls for regulating low-amplifier output relative to high-amplifier output. Since such controls are not provided, readers who plan to use the VFX-2 in a home audio system should make certain that their individual stereo power amplifiers have input level controls so that woofer and tweeter levels can be adjusted. A study of the internal construction and layout of the VFX-2 indicated that it is built to professional standards, uses top grade components, and should remain trouble free for many years. Even used as a simple bandpass filter (for high-cut scratch filtering and/or low cut rumble filtering), the unit proved far more effective than the usual "high cut" and "low cut" filters normally found in integrated amplifiers or receivers, thanks to its steeper (18 dB-per-octave) slopes and more precise filter action.



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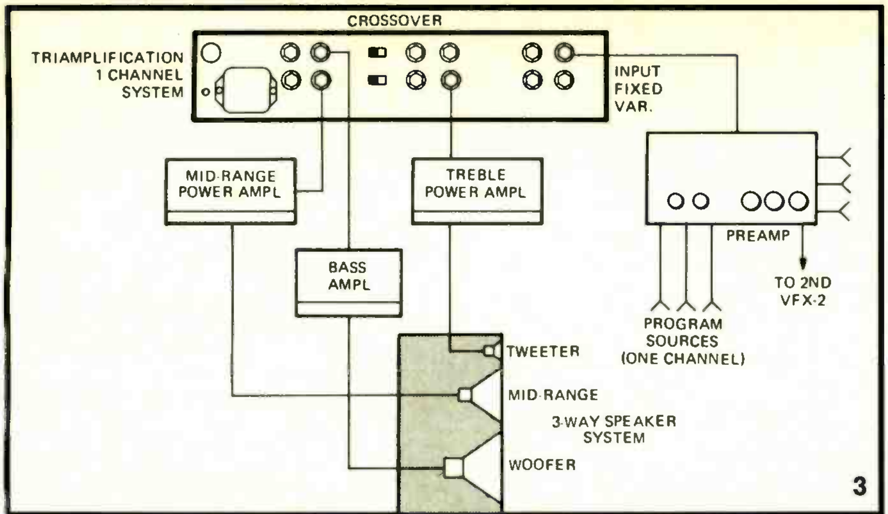

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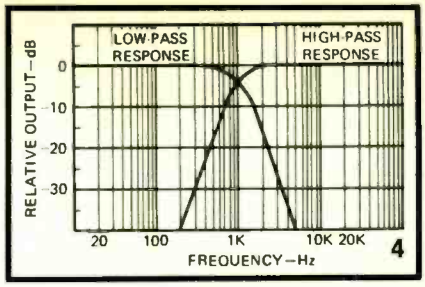

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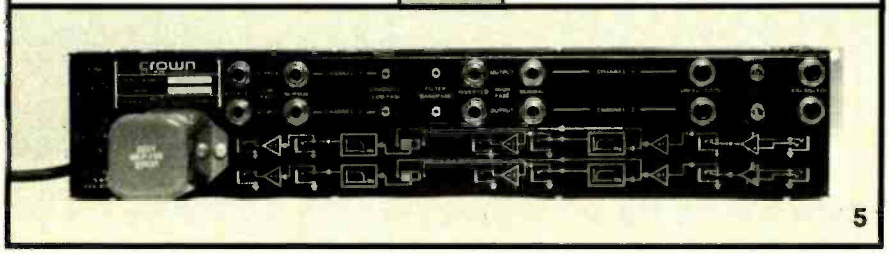

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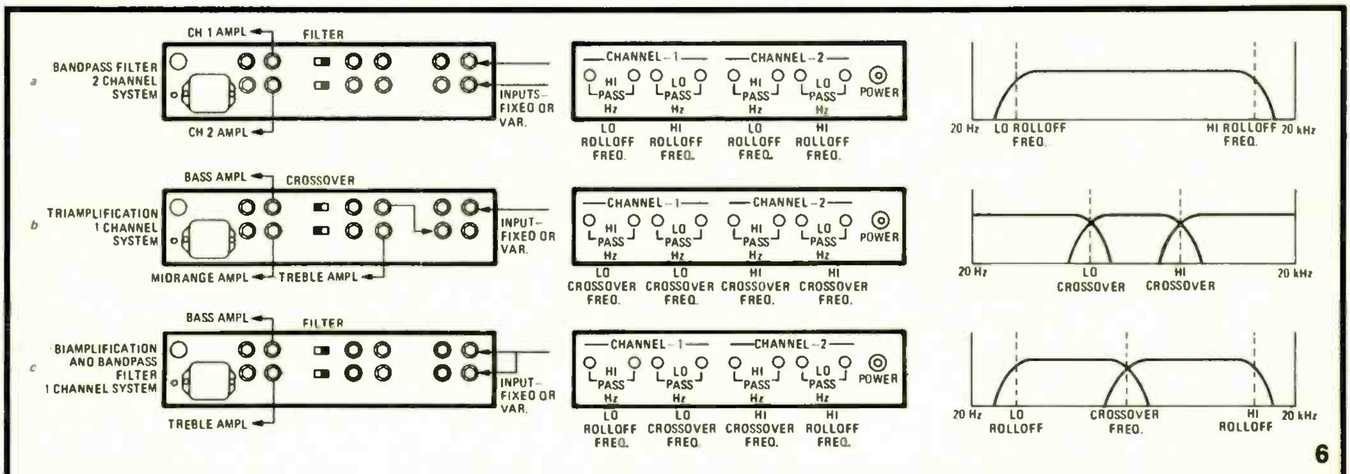
the LOW PASS OUTPUT jack depending upon the position of the RANGE switch.

The RANGE switch determines the appropriate group of 5% matched capacitors to be used in the filter stages. High-vernier potentiometer (R14, R16, R18) and low-vernier potentiometer (R23, R25, R27) are matched sets of three 15K ohm resistive elements used to determine the corner frequency of each filter. The signal from IC1-b is applied through selected RC filter components to dual operational amplifier IC2-a that, along with IC2-b and IC3-a, forms a 3-pole high-pass 18 dB/octave Butterworth filter. This delivers the non-inverted high-pass output, while operational amplifier IC3-b delivers the high-pass inverted output.

(continued on page 73)



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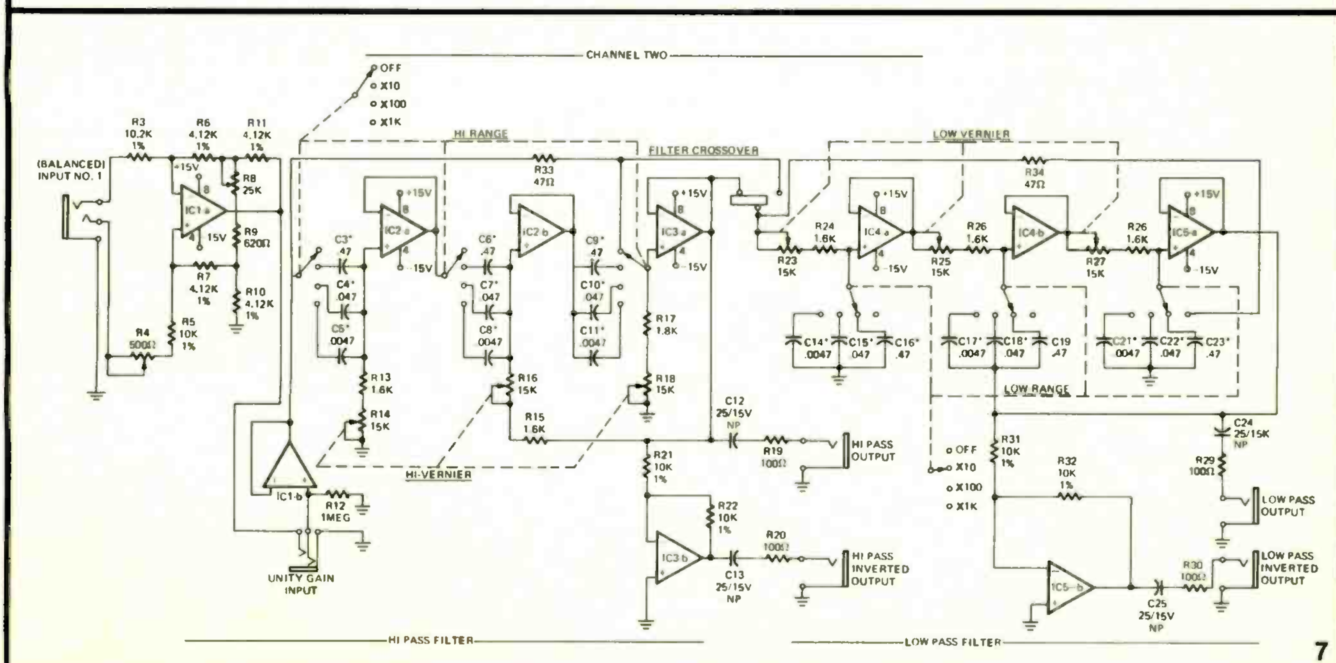


7

BUILD this COLOR TV for about

This month the circuit
head adjustments are
we'll show you how to connect

by GARY DAVIS

LAST MONTH WE PRESENTED THE color processing, block diagram, and general layout of a low-cost color TV camera. This month we will cover the camera heads in detail, including adjustments and registration.

The vidicon tube

Each camera head consists of three basic units. The vidicon-tube assembly, the video preamp and the deflection components. Before we discuss the camera circuitry, let's briefly examine the operation of a vidicon image pick-up tube. The tube contains a signal plate of a conducting metallic film, so thin that it is transparent. One side of this plate is coated with a thin layer of photo-conductive material, such as amorphous selenium. The optical image is focused on the opposite side of the signal plate. The photo-conductive material is scanned with an electron beam originating at the vidicon cathode.

The scanning beam deposits just enough electrons on each spot that it touches, to reduce the potential of that side of the metallic film to the cathode potential. However, during the interval

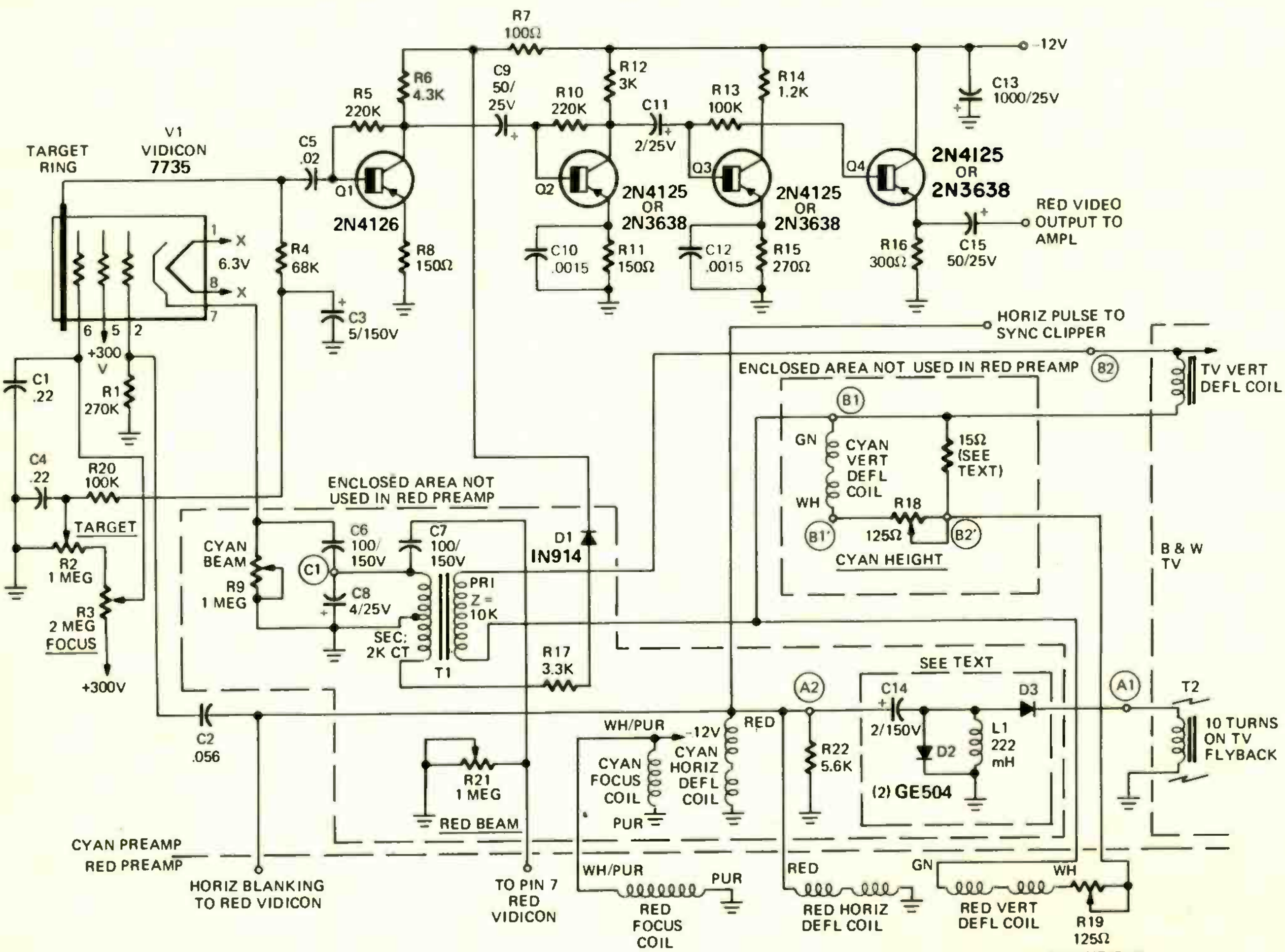
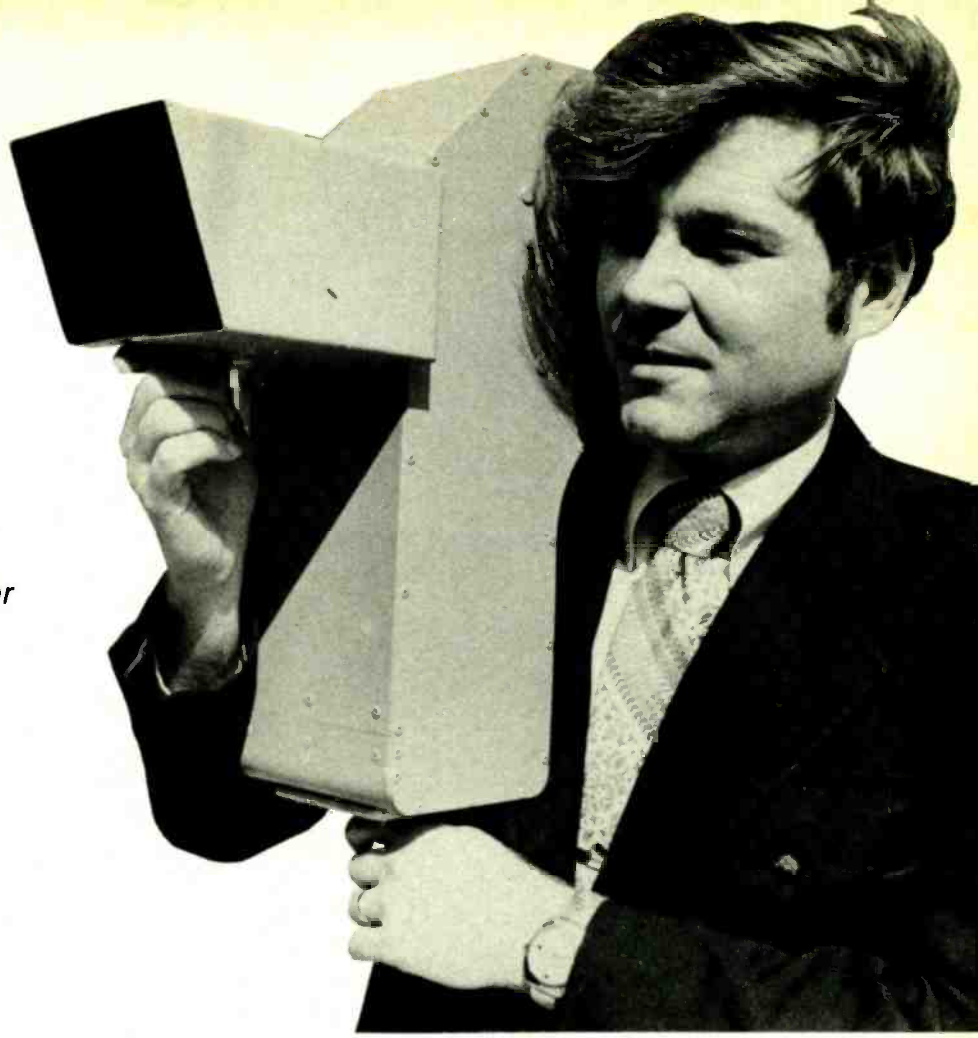


FIG. 2—PREAMPLIFIER for the cyan and red video channels. All components above the dotted line, except where noted, are duplicated for red video channel. A black-and-white TV receiver supplies the operating voltages, sync and blanking signals to the camera head.

CAMERA $400

details and camera covered. Next month, the camera head to a color monitor



between successive scans, a charge leaks through the photo-conductive material in proportion to the illumination. The charge deposited on any particular spot of the photo-conductive material the next time it is scanned, is enough to replace those electrons that have been lost by leakage since the last passage of the beam. The total current of the electron beam and the capacitance of the photo-conductive material is in series with the external load resistors.

The preamp

In this camera so much light is absorbed by the color filters and prism, that only a very low level of light actually strikes the vidicon photo-conductive surface. Therefore, the video amplifier must work with a very low signal-to-noise ratio. The schematic diagram of the preamp circuits are shown in Fig. 2. Transistor Q1 should be a low-noise type 2N4126, and may have to be individually selected for low-noise content after the camera is in operation. One should not be satisfied with the signal-to-noise ratio until with sufficient illumination, the pictures are about as noise-free as those received from a local commercial TV station. It will probably not be necessary to individually select the other amplifier transistors.

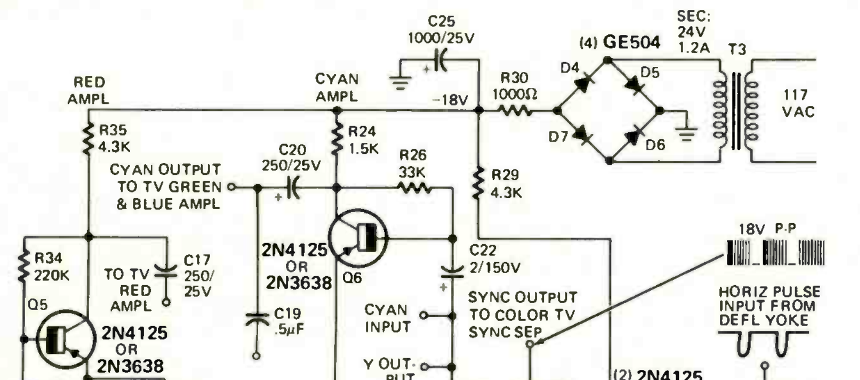


FIG. 3—COLOR AMPLIFIERS and sync circuit. The video and sync outputs are connected directly to the color difference amplifiers and sync separator of the color monitor.

The video amplifier should be mounted inside a metal box to shield the amplifier from extraneous signals. It is important to use short leads and the amplifier should be mounted on the focus coil assembly so that the signal lead from the vidicon target connector to the video preamplifier input is no longer than one inch in length. In dealing with low signal levels at the vidicon output, ground loops and sufficient grounding between components becomes extremely critical. A general rule would be to ground everything possible with short ground leads, including the lens mount and the lens. Good results with my camera were obtained with an unshielded wire for a target lead. However, in metropolitan areas or areas with strong RF signals, a shielded wire may be necessary.

Vertical sync is added to the cyan signal through diode D1 at Q1. The addition of vertical sync slightly tilts the video waveform. However, it has negligible shading affect on the picture. Capacitors C10 and C12 boost the high-frequency response to increase the upper frequency limit of the entire video amplifier. Low-frequency negative feedback is introduced to each stage individually by connecting the bias resistor to the collector load resistance. This arrangement further enhances the relative high-frequency response of each stage. The entire video amplifier has a voltage gain of approximately 300. The color amplifier and sync circuits are shown in Fig. 3.

Deflection and focus assembly

Due to the fact that the red camera head sees a mirror image of the actual scene, the phase of the deflection signal to the red yoke must be taken into consideration. Focus coil windings for both vidicon tubes should have the purple wire grounded (see Figs. 2 and 4), and the white/purple wires connected to −12V. On the vertical windings, yellow is not used. White wires are connected to their respective height controls R18 and R19. The green wires are connected together and common to T1. On the horizontal windings, the red wires are connected together. The cyan black wire is connected to point A2. The red channels' black wire is grounded. Both gray wires of the electrostatic shield should also be grounded. The blue wires are not used. With this wiring arrangement, the deflection assembly should be mounted with the focus coil lead exit-holes for the cyan channel opposite the mounting board. The red-channel focus coil lead exit holes should be next to the mounting board. This arrangement applies to type CY101-1547 deflection assembly available from Denson Electronics.

The vertical deflection coils require 6 V P-P for proper deflection as shown on waveform B1. Each horizontal deflection coil requires 30 to 40 V P-P as shown on waveform A2. It should be noted that for proper operation, the camera requires waveforms and voltage amplitudes as shown. They are supplied by a small B/W monitor.

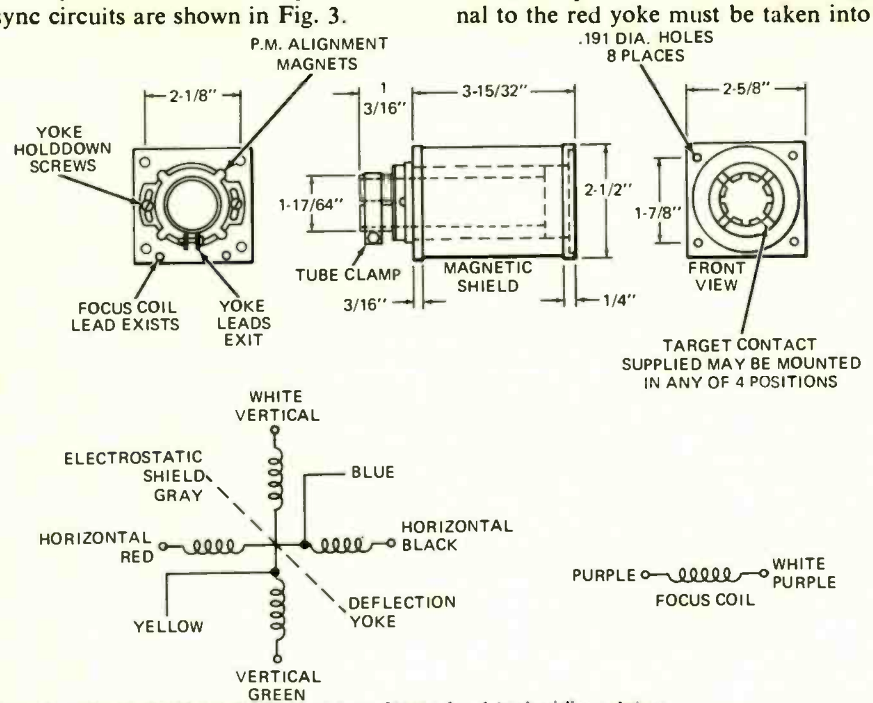


FIG. 4—DEFLECTION ASSEMBLY of type CY101 for 1-inch vidicon tubes.

Blanking and sync

Transformer T1 supplies both the vertical sync and the vertical blanking signal. The center tap of the 2K secondary is grounded. Phasing should be observed with an oscilloscope insuring that the positive going pulse is applied to test point C1. Capacitor C8 stretches the pulse and sets the amplitude to 7 V P-P. Capacitors C6 and C7 then apply the blanking pulse to cut off the vidicon cathodes during vertical retrace. C8 may have to be selected for use with some types of vidicons if black retrace lines appear in the picture. The other half of the secondary feeds a negative-going vertical sync pulse to diode D1. Polarity of diode D1 should be observed as shown on the schematic. A horizontal sync pulse is taken from point A2 and fed to the monitor separately.

Initial vidicon tube adjustments

The following adjustments are made with all voltages and scanning signals applied to the camera from the B/W monitor. Potentiometer R3 serves as a focus control. Initially, the beam control R9 should be adjusted for maximum resistance. The target control should be adjusted for about 40 to 50 volts at the center terminal. The focus control should be set about midway. The beam control should be adjusted until blobs of light and dark areas ap-

(continued on page 74)

PARTS LIST

All resistors are ½-watt 10% unless noted

*R1—270,000 ohms
*R2, R9, R21—potentiometer, 1 megohm, linear taper
*R3—potentiometer, 2 megohms, linear taper
*R4—68,000 ohms
*R5, *R10, R34—220,000 ohms
*R6, R29, R35—4300 ohms
*R7—100 ohms
*R8, *R11, R23—150 ohms
*R12—3000 ohms
*R13, *R20, R28, R33—100,000 ohms
*R14—1200 ohms
*R15—270 ohms
*R16—300 ohms
R17—3300 ohms
R18, R19—potentiometer, 125 ohms, wirewound
R22—5600 ohms
R24—1500 ohms
R25—180 ohms
R26—33,000 ohms
R27—18,000 ohms
R30—1000 ohms
R31—120,000 ohms
R32—2200 ohms
*C1, *C4—.22 µF, 300V
*C2, C24—.056 µF, 200V
*C3—5 µF, 150V, electrolytic
*C5—.02, 100V
C6, C7—100 µF, 150V, electrolytic
C8—4 µF, 25V, electrolytic
*C9, *C15—50 µF, 25V, electrolytic
*C10, *C12—.0015 µF, 25V
*C11—2 µF, 25V, electrolytic
*C13, C25—1000 µF, 25V, electrolytic
*C14, C22—2 µF, 150V, electrolytic
C16—25 µF, 225V, electrolytic
C17, C20—250 µF, 25V, electrolytic
C18—.01 µF, 50V
C19—0.5 µF, 200V
C21—.0022 µF, 50V
C23—.33 µF, 150V
C26—.0082 µF, 150V
D1—1N914 diode
D2-D7—400PIV, 2.5A rectifier (GE504 or equal)
*Q1—2N4126 transistor
*Q2, *Q3, *Q4, Q5-Q8—2N4125 transistor
L1—222 mH inductor
*V1—7735 vidicon tube
T1—10K-2K impedance matching transformer (Radio Shack No. 2731378 or equal)
T2—10-turns on TV flyback (see text)
T3—117V primary; 24V, 1.2A secondary
Vidicon filament transformer 117V primary; 6.3V CT, 3A secondary

***Two each of the components are required to construct both video channels.**

MISC—two 4 × 2½ × 1⅝ in. aluminum mini-boxes (Bud no. CU3002A) ½ in. plywood mounting board, aluminum sheet metal for camera case, lenses, yokes, deflection coils, lens mounts, vidicon sockets, color filters, prism, wire, solder, etc.

NOTE: the following parts are available from Denson Electronics, P.O. Box 85, Longview St., Rockville, CN 06066. Two yokes and focus coils no. CY101-1547, two vidicon sockets, two Comsicar 32939 lenses, two size C lens mounts. The following parts are available from Edmund Scientific Co., 91 Edscorp Bldg., Barrington, N.J. 08007. One 2x2 in. Plexiglas red no. 2423 color filter, two 2x2 in. Plexiglas green no. 2414 color filters, one cube prism.

To meet the severe demands placed upon today's tape transports, manufacturers have, among other things, introduced logic control. Here's how they work.

inside today's tape transports

by LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

LAST MONTH I DISCUSSED TAPE EQUALIZATION AND BIAS AND their effect on frequency response, signal-to noise ratio and distortion of a tape recorder. These, and other purely electronic characteristics of tape recording and playback have been thoroughly covered in the high-fidelity literature in recent years. Considerably less emphasis has been given to the tape transport mechanism itself—the elements in a tape deck that mechanically position and move the magnetic tape over the tape heads.

Actually, the demands made upon a high-quality tape transport mechanism are much more severe than those upon a phonograph turntable of equivalent quality. The turntable is called upon simply to turn at a constant speed. The tape transport, in addition to moving tape at relatively slow speeds, must also be able to rewind or forward wind large and small reels of tape at very fast speeds and must be able to bring all motion to a safe stop without spilling, ripping or in any way damaging the tape.

From the earliest, purely mechanical, one-motor transport systems equipped with all kinds of friction-braking devices, multiple belts and other schemes subject to wear and misadjustment, the tape recording industry has progressed to a variety of fail-safe all-electronic, computer-logic activated transport systems that have no brake shoes or other friction devices—no mechanical linkages or gadgets to wear out.

A typical example of sophisticated electronics brought to bear on the mechanical functioning of a tape transport is to be found in Crown International's 800 series tape transport (Fig. 1). Its belt-driven capstan is powered by a hysteresis synchronous motor. In addition, two reel motors take care of tape-up and tape-feed tension, fast forward, rewind and braking.

In PLAY, take-up tension is controlled by an AC voltage applied to the take-up motor, while feed tension is controlled by an AC voltage applied to the tape-feed motor. In FAST FORWARD or REWIND, the pulling motor is fed a full 117 VAC while the opposite motor has only 35 VAC applied for a slight holdback tension. All of these actions, including automatic shut-off whenever tape runs out or whenever a transparent segment of tape passes through, are governed by fully electronic command signals derived from digital electronic circuitry that is detailed in the schematic diagram of Fig. 1. Crown's excellent owner's manual gives the user a complete insight into the functioning of the transport and its electronics, and from it we were able to derive the following explanation of the various sections of the circuitry.

Tape sensing

The tape sensor feeds a "stop" command to the computer (commands, memory and gates sections) whenever the tape runs out or a transparent length of tape is sighted. This is done by positioning a photocell (PC1) on one side of the tape path and a lamp on the other (See Fig. 1.). Light reaching the photocell causes its resistance to decrease, turning on transistor Q11 and presenting a low ("O") voltage to the input of inverter IC1-f. The output of this inverter is then a high ("1") voltage which gives the "stop" command through transistor Q12.

The tape sensor circuitry also incorporates a dual-speed function. A longer time span, is required before the stop command is issued when the transport is in PLAY than when it is in FAST-WIND since the tape is moving at a slower rate. When operating in PLAY, transistor Q10 is turned on, placing capacitor C19 in the photocell circuit and increasing its time constant. In any mode but PLAY, the circuit senses a transparent length of tape or senses when the tape runs out in from 1 to 3 milliseconds. In PLAY, it takes more than 10 ms for the stop command to be issued. This prevents an erronious stop command caused by poor splices or pinholes in the tape.

Motion and direction sensing

Since the direction and speed of the tape has a direct bearing on reel tensions and reel braking, a system of motion and direction sensing had to be devised for the transport. Circuitry for this function is shown in the upper left block of Fig. 1. Mechanically, the motion sensor uses a pair of slotted discs that modulate a light beam in front of one of two photocells (PC2 and PC3). The first disc rotates with the tape-feed reel motor shaft and causes the light to flash on the photocell whenever this shaft rotates. The second disc forms an aperture

TRANSPORT SECTION of Crown series 800 tape recorders. Audio electronics is a separate circuit.

Communications Engineering

Aeronautical & Navigational

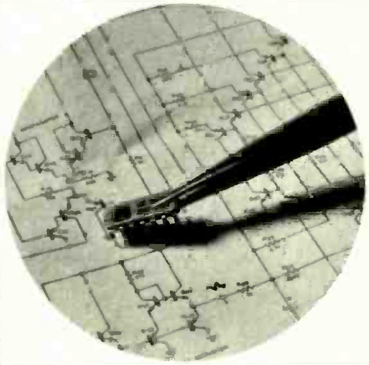
Television Engineering

Automatic Control Engineering

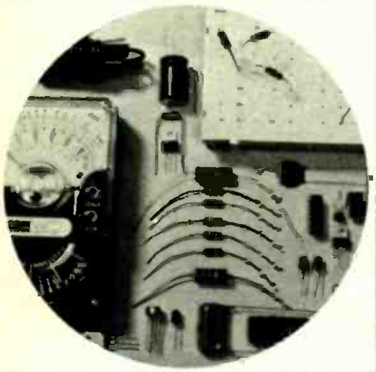
Missile & Spacecraft Guidance

Radar & Sonar Engineering

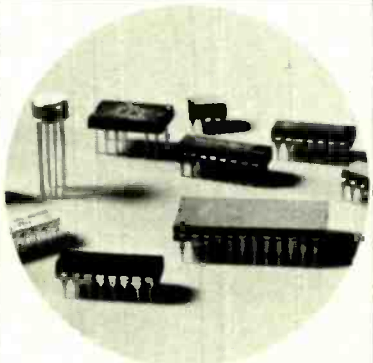
Digital Communications



Industrial Electronics



Microwave Engineering



Satellite Communications

Cable Television Engineering

Electronic Engineering Technology

Nuclear Instrumentation & Control

Special Programs for Electronic Engineers

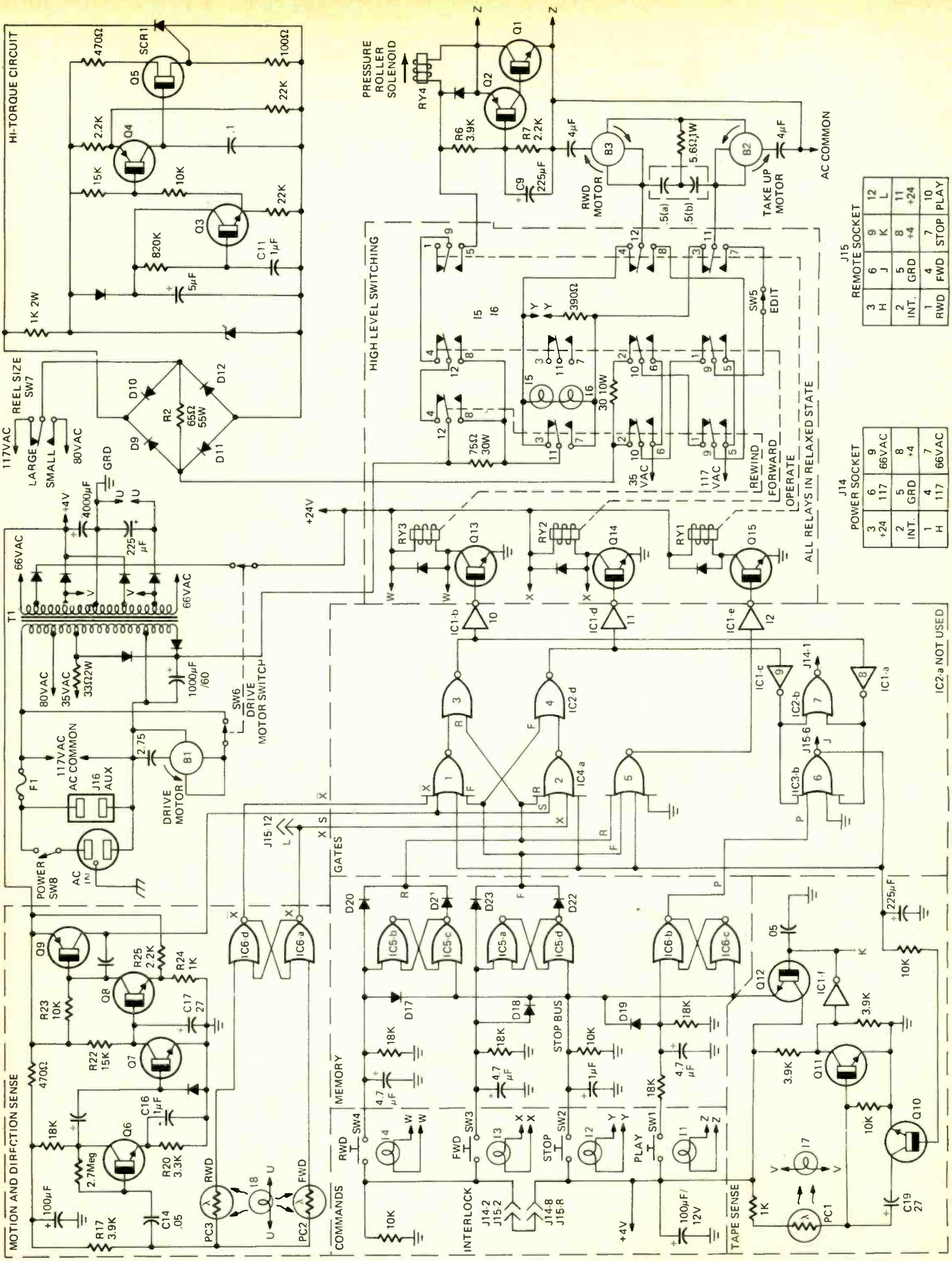


FIG. 1—ELECTRONIC CONTROL section of the transport system.

between the first wheel and the photocells, masking one cell while revealing the other. This second disc is fastened to a ball bearing that rides the rotating shaft and is free to turn with it until it encounters a stop where it exposes either the forward or the rewind photocell, depending upon the direction of motor rotation.

The photocells have one common lead that supplies power to them. Each cell is connected to the input of a set-reset direction-sensing flip-flop (IC6-a and IC6-d). This flip-flop stores the direction information received from the last light pulse seen by the photocells. If the last photocell illuminated was the forward cell then the flip flop remains in the set state. Storing this direction information makes it available even during the dark half of a light flashing sequence. When light flashes on one of the photocells, its resistance changes, developing a pulsating DC voltage on supply resistor R17. This voltage is coupled via C14 to Q6 where it is amplified. Because the photocell output decreases with increasing frequency, emitter resistor R20 is bypassed by C16 to increase the gain of Q6 at higher frequencies.

Transistor Q6 drives a detector circuit that provides a low voltage ("0") when pulsating DC is detected. A threshold detector made up of Q8, Q9, R23, R24 and R25 measures the voltage stored on capacitor C17. As motion occurs, transistor Q7 is intermittently turned on by the pulsating DC voltage from Q6. This causes C17 to be discharged at a rate higher than it is being charged by R22, turning off the threshold detector. Time constants are arranged so that motion can be sensed almost immediately. But to sense a lack of motion (stop condition), a short delay formed by the time constant network R22 and C17 must elapse. This permits high braking to continue even after rotation has slowed down to a rate too low to be detected by the motion sensor.

Tape lifter and pressure roller pull in

Tape guides and heads are positioned so moving tape does not contact the heads except when the transporter is in PLAY. A tape-lifter assembly provides enough tape to the head contact area when the transport is in PLAY. A cross section of the tape lifter assembly is in Fig. 2, while Fig. 3, shows the same tape lifter solenoid applying the tape pressure roller during PLAY. Powered through relays from the same power supply that is used for the braking system, the pressure roller and tape-lifter solenoid relaxes after pull-in due to an electronic circuit in series with the solenoid coil.

The voltage drop across transistor Q1 (see Fig. 1) is essentially the same as the voltage on capacitor C9. At turn on, C9 is at zero volts and begins charging towards a value determined by voltage divider R6 and R7. During the beginning of this charge cycle, the solenoid becomes seated. Once seated, its power requirements are substantially reduced. For this purpose, lamp I1 (shown in the "commands" section of Fig. 1) is wired in parallel with Q1. If the "play" lamp (I1) is on, it indicates proper operation of the solenoid relaxing circuit, in addition to its more obvious indicating function.

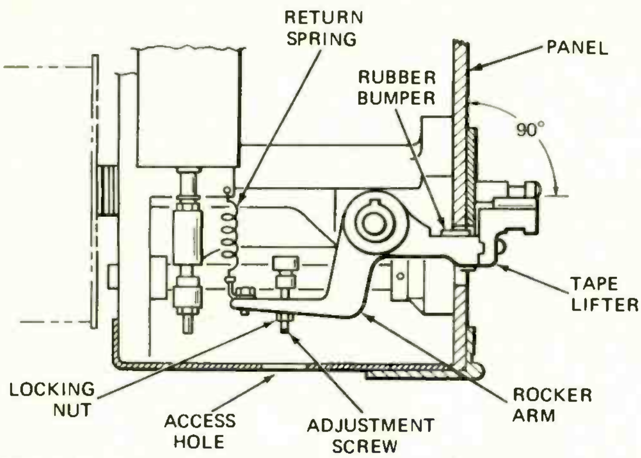


FIG. 2—TAPE LIFTER assembly moves tape against the heads during play mode.

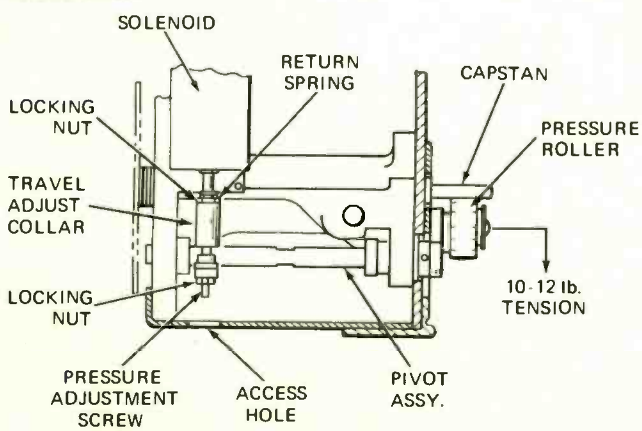


FIG. 3—SAME SOLENOID used in tape lifting also applies the pressure roller against the tape capstan during the play mode.

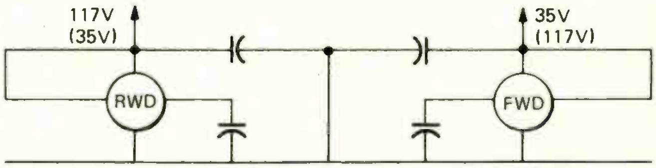


FIG. 4—VOLTAGES SHOWN without parentheses are applied to reel motors during rewind. Voltages in parentheses are applied during fast forward.

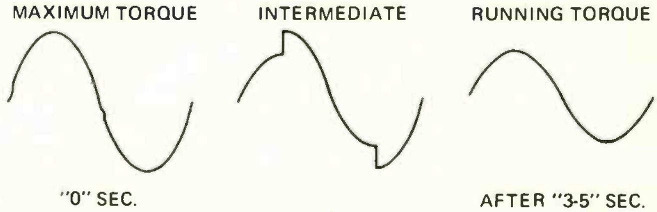


FIG. 5—VOLTAGE WAVEFORM sequence for high starting torque.

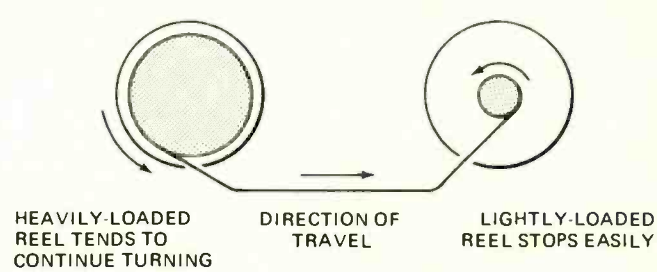


FIG. 6—IMPROPER BRAKING differential will result in tape spillage under this condition.

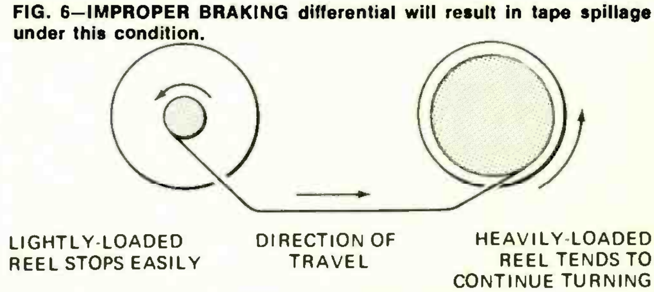


FIG. 7—IMPROPER BRAKING differential will result in stretched or broken tape under this condition.

Powering the reel motors

During FAST REWIND and FAST FORWARD, full 117 VAC is applied to that reel motor which is doing the pulling, while the trailing motor is fed approximately 35 VAC, as in Fig. 4.

To get fast, smooth starting when going into PLAY, extra power is applied to the reel motors to help them overcome stationary inertia. If this extra torque is not reduced gradually, a wobble appears in the tape motion. To provide this drop-back, a two terminal network is placed in series with the reel motors. The impedance of this network is very low for a second or so, increasing to its maximum value after about three seconds. The network consists of resistor R2 shunted by an

(continued on page 89)

All About OSCILLOSCOPES

PART III—Operating the oscilloscope properly is covered plus several measurements that can be made

by CHARLES GILMORE*

USING MOST TEST-EQUIPMENT IS STRAIGHT-forward and little knowledge is required by the user when moving from one manufacturer's product to another or when performing simple tasks. The oscilloscope does not follow this pattern.

The many types of oscilloscopes available and the relative complexity of all oscilloscopes in comparison to other test-instruments make it necessary for the user, especially the casual or infrequent one, to follow some simple initial operating rules. If they are not followed, you'll waste a lot of time and effort while attempting the apparently simplest of procedures. Therefore, in this article we will establish initial operating rules for an oscilloscope. Once mastered, you'll know how to use a seemingly more complicated and sophisticated instrument such as a triggered scope.

A trace on the screen

When using a new or unfamiliar oscilloscope, the first step is to get a trace. Plug in scope. Turn it on and let it warm up. Some oscilloscopes, especially those using vacuum tubes, require as much as one to two minutes before any trace can be obtained. All scopes should be allowed additional warm-up time before use to eliminate trace drift. After warm-up, set the time base (horizontal or sweep frequency) switch to a medium sweep-speed and place the AUTO/NORMAL switch (triggered oscilloscopes) in the AUTO position. Turn up the intensity control with the vertical and horizontal position controls set at the center of rotation. A trace in the form of a horizontal line, should appear. If, at full intensity, there is no trace, look for a general lighting or glow at one of the edges. This gives an indication of the off-screen direction of the trace. Then use the vertical and horizontal position controls to center the trace on the screen.

If this technique does not work, a more systematic approach may be used. Return the vertical and horizontal position controls to their midway points. Now systematically rotate the horizontal position control in small increments. After each correction of the horizontal position control, move the vertical-position control through its entire range to locate the trace. Do not rotate the vertical-position control quickly or the beam may cross the CRT face too rapidly to be seen.

*Design Engineer Heath Company, Benton Harbor, Mich.

Beam adjustments

Once you've got the trace, switch the time base to the external horizontal position. A dot rather than a line should now appear on the face of the CRT. Adjust the focus, intensity and astigmatism controls for the smallest roundest dot possible. This procedure insures the sharpest trace. The FOCUS, INTENSITY, and ASTIGMATISM controls all interact. When in use, trace brightness variations may require refocusing.

Displaying a waveform

Adjust the vertical and horizontal position controls to center the trace vertically and to start the trace at the left side of the CRT. Set the time base at a mid-range position, for internal trigger or synchronization (either + or —). Triggered scopes should be in the auto mode.

Once you have a trace, a signal must be connected to the scope to observe a waveform. Obviously, you need some form of cable or probe to connect the signal to the vertical input jack. Then the vertical input switch is used to select the AC or DC position, depending upon the information desired from the trace. A common error is to leave the vertical input selector AC-DC-GROUND switch in the GROUND position. If uncertain about the relative amplitudes of AC and DC components of the input waveform, use the AC position first. Select an attenuator setting commensurate with the expected input signal amplitude. If the amplitude is unknown, use the *highest* attenuation level (lowest sensitivity) possible. Adjust the attenuator to produce a trace from ½ to ¾ of screen height. When performing initial adjustments, keep both the vertical attenuator and the horizontal-variable controls in their calibrated positions. Leaving these controls in their uncalibrated positions is a frequent source of error.

Once you have a trace, set the time-base switch to display a few cycles of the input waveform. The trace may not be stable at this time; however, you should be able to see enough of the unstabilized trace to determine an approximate time-base setting. With this setting, a triggered scope in the auto position may need level-control adjustment to produce a stable pattern. Some scopes use the level control in the AUTO position and some do not. With the recurrent-sweep oscilloscope, the coarse and fine time-base controls are set to produce the desired number of cycles of display. If there is a sync-level control, you may have to adjust it to stabilize the trace.

Triggering in the automatic mode

The auto mode of triggering is the one that is most frequently used. Auto triggering has the advantage of maintaining a trace (baseline) when triggering is lost because of low-signal levels.

Auto trigger is designed to trigger relatively simple waveforms above 100 Hz to an upper-frequency limit near that of the scope's vertical bandwidth. If the frequency of the waveform is out of this range or the waveform is complex, normal mode is preferred.

In the AC-coupled auto mode, a trigger signal is generated when the displayed waveform passes through the zero voltage point of the AC portion of the waveform. AC-coupling should be used, as the auto mode is not designed for low-frequency work. Below the frequency that is the automatic trigger-rate of the baseline generator, the automatic baseline generator takes over between cycles of the displayed waveform. When this occurs, normal mode should be used.

When DC-coupled automatic triggering is used (not available on all oscilloscopes), a triggering signal is generated as the displayed waveform passes through an imaginary line representing zero volts. The user must be sure that the signal does pass through this zero-volt line to get triggering. To determine where this imaginary line is, set the vertical input selector switch to the ground position. This operates the automatic baseline generator and establishes a trace whose position is the zero-volt imaginary line. Varying the vertical position control varies this line that represents the triggering point. DC-coupling of the automatic mode may be required when examining signals with low duty cycles, or those with a DC offset greater than their AC amplitude. Figure 14 shows the effect of varying the vertical position control with AC and DC trigger coupling in the automatic mode.

If AC/DC trigger coupling is not available on a particular oscilloscope and DC coupling is necessary to properly trigger the waveform, switch to normal triggering. Such scopes consider auto triggering AC-coupled and normal triggering DC-coupled.

Slope control

The SLOPE control permits the user to

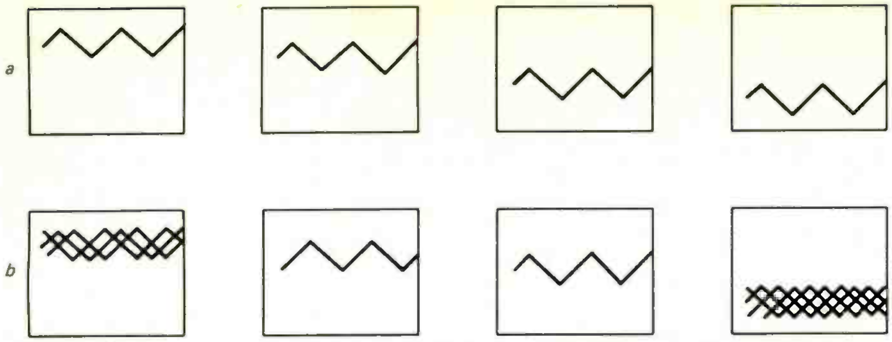


FIG. 14—WAVEFORMS shown in a are AC triggered. Waveforms in b are triggered via DC coupling.

FIG. 15—EFFECT OF TRIGGERING on positive edge is shown in a, while negative edge is shown in b.

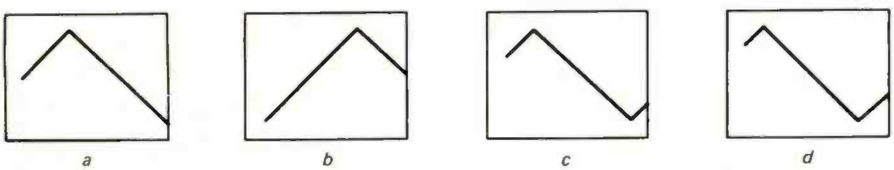


FIG. 16—THE EFFECT of varying the trigger level control while observing a triangle waveform.

select triggering on either the positive- or the negative-going slope of the waveform. Figure 15 shows the effects of slope adjustment. One of the most important uses of the SLOPE switch is when examining pulses where the desired point for observation is on one edge or another of the waveform. Slope selection followed by trace expansion with the time-base control will permit detailed examination as shown in Figure 15. The SLOPE control is independent of trigger mode or coupling.

Triggering in the normal mode

Normal mode triggering is useful when you want to trigger at a specific point on the displayed waveform. When normal mode is used, the LEVEL control is used as well as the COUPLING and SLOPE controls. Figure 16 shows the effect of varying the LEVEL control on a triangle waveform. The NORMAL mode is needed only when the signal cannot be properly triggered in the AUTO mode. An oscilloscope being used at the limits of its frequency capability requires the normal mode for good triggering.

At the opposite end of the frequency spectrum, the NORMAL setting is also required. As noted above, the automatic baseline generator may interfere with low-frequency triggering in auto mode, and on some oscilloscopes there is no way to truly DC-couple the trigger signal in the auto mode. In this case, signals that are extremely low in frequency or those having DC-offsets greater than their AC amplitude must be triggered in the normal mode. This is especially true of older scopes. In some modern oscilloscope designs, the difference between automatic and normal modes is simply one of an automatic baseline generator. In these instruments, the reason for using the normal mode may be no more than keeping a trace off the CRT when no signal is applied or for very high frequency operation.

Vertical measurements

The simplest of all vertical measurements is peak-to-peak amplitude. Figure 17 shows a waveform with a 3-cm vertical

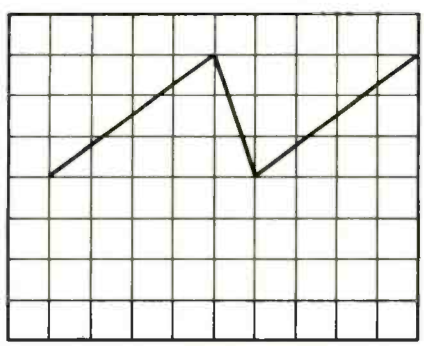


FIG. 17—A RAMP SIGNAL displayed on an oscilloscope with a calibrated vertical attenuator.

amplitude. The vertical attenuator is set at 0.2 volts-per-cm to produce this display; therefore, the waveform amplitude is 0.6 volts (3cm × 0.2 V/cm). Remember, the measurements are peak-to-peak voltage measurements. An oscilloscope cannot make RMS or average measurements directly. Such measurements must be calculated by knowing the peak-to-peak amplitude and dividing by 2.828 (for triangle waveforms only) to arrive at an RMS value. For the square wave (50% duty cycle), the peak-to-peak value is its RMS value. However, with more complex waveforms, conversions involve extensive calculations.

If the oscilloscope has DC-coupling, DC voltages can be measured. A measurement of a DC plus an AC voltage can also be determined. Figure 18-a shows AC-coupling with the waveform centered on the screen. The oscilloscope is set to 10 mV/division. A sinewave signal is measured at 60 mV peak-to-peak. In Figure 18-b, the

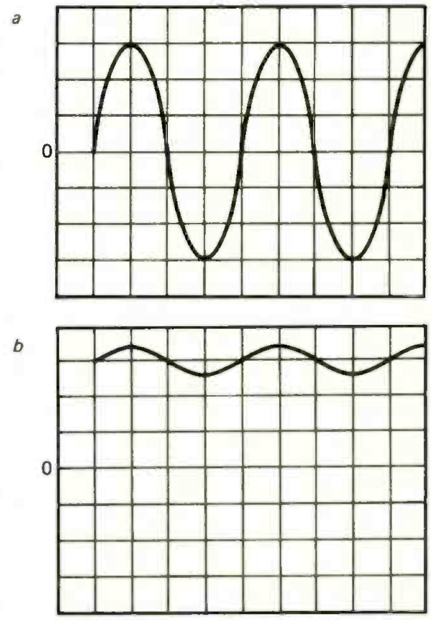


FIG. 18—MEASUREMENT of the peak-to-peak amplitude of an AC signal riding on a DC offset voltage.

input attenuator reduces the sensitivity of the oscilloscope to 1 V/division. DC coupling shows the AC waveform to be riding on a DC signal of 3 volts. Using the ground position of the vertical input coupling switch is a common way to establish the zero-volt reference line.

Horizontal measurements

While vertical measurements yield signal amplitude, horizontal measurements give a measurement of time. Most triggered oscilloscopes with calibrated time bases specify the time-per-division. As most measurements involve more than one division, a multiplication of the time-per-division settings and the number of divisons involved is required.

If the magnifier is used, the final period measurement must also include the magnifier multiplier.

The period of a waveform is defined as the time required for the waveform to completely repeat itself. With a triggered oscilloscope having a calibrated time base, this measurement can be easily made. Suppose that the length of a sawtooth waveform is 5 divisions. The time base setting for the display is 0.5 ms-per-division. The period of the waveform is 0.5 ms-per-division multiplied by 5 divisions, or 2.5 ms. The reciprocal of period will yield frequency, in this example, 400 Hz.

Risetime measurements

As previously indicated, risetime is the time required for the leading (positive going) or trailing (negative going) edge of a wave to pass from 10% to 90% of its full amplitude. When measuring rise-time, it is preferable to expand the trace, by adjusting the timebase, to spread the rise or fall of the signal over as many horizontal divisions as possible. A slope of 45° is the most desirable although it is not always achievable.

The signal should also be spread over as many vertical divisions as possible. Use the variable vertical attenuator to reduce the amplitude of the signal to an integral number of divisions (five for example.) Such an adjustment facilitates measuring the 10% and 90% amplitude points. Using the variable vertical attenuator may introduce some error in the risetime measurements. Do not use this adjustment if extreme accuracy is desired, or if the measurement is near the risetime specification of the oscilloscope.

Dual-trace measurements

When using a dual-trace scope, the operator must decide on alternate or chopped mode and trigger source selection (channel 1, channel 2, or mixed).

Some dual-trace scopes require the operator to select between chopped and alternate modes. Other scopes do this automatically. The optimum point to switch from chopped to alternate mode will vary slightly with the waveforms to be observed. However, changeover as the timebase reaches 1 ms-per-division is a good choice.

Chopped mode at fast timebase rates will produce a square wave on the CRT with no signals applied to the oscilloscope. This can be confusing. Triggering selection usually offers the alternatives of one of the two vertical input channels, or the combination of both channels. If the two signals to be observed are time (phase) related, but have a frequency difference, triggering should be selected from the lowest frequency channel. For example, Figure 19 shows a dual-trace display of the

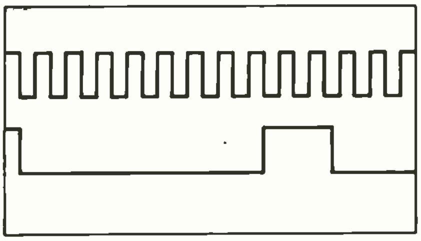


FIG. 19—INPUT AND OUTPUT waveforms from a BCD counter. Triggering is on the trailing edge of output waveform.

input and output waveforms of a BCD TTL counter. The upper trace is the input and the lower is the output. Triggering is selected to be on the negative slope of the lower waveform, thus insuring only one sweep for each output pulse.

If two signal channels have no time or phase relationship and may have a frequency difference, the combination mode may be desired.

One of the most common uses of the dual-trace scope is to compare an output waveform to an input waveform for general changes in the wave-shape. The position controls may be used to superimpose the input and output waveforms, making differences quite noticeable.

Another useful dual-trace measurement is to determine time differences. Figure 20 shows 300-ns delay between the leading edge of the upper and the leading edge of the lower pulse. A common source of error in time measurements is improper triggering source selection. The triggering must be made from the start signal. Using the stop signal as a trigger source would yield a measurement of stop to start time, which may or may not have meaning. Think in terms of cause and effect when selecting the trigger source for such measurements.

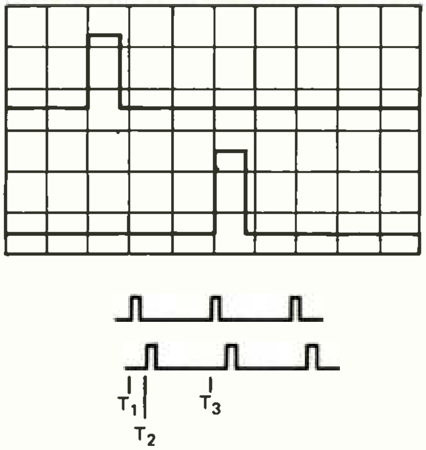


FIG. 20—MEASUREMENT of delay time between two pulses. Triggering must be from upper waveform.

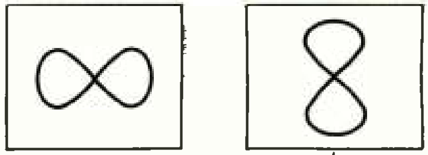
X-Y frequency measurements

An application that is older than the oscilloscope itself is a measurement of frequency by the use of the Lissajous pattern. It can be shown geometrically, that plotting two sinewaves of the same frequency, but with a 90% phase-shift, will result in a circle. This leads to a technique for frequency measurement. A reference frequency is applied to the horizontal axis of an oscilloscope (operated in the X-Y mode) and an unknown frequency of the same amplitude is applied to the vertical axis. When a perfect circle or, for all practical purposes, something close to a perfect circle, is achieved, the two frequencies are identical.

The difference between the frequencies of the X and Y signals, for small differences, may be measured by watching the circle alternately collapse and expand (rotate). Two circles will be produced each second for each cycle of difference. For example: suppose the horizontal axis is supplied with a 100 kHz reference frequency and the unknown frequency is applied to the vertical axis. If, in the course of 10 seconds, four perfect circles are made, there is a two cycle per 10 seconds or 0.2 Hz difference between the two frequencies. The measurement does not determine whether the reference frequency is higher or lower in frequency.

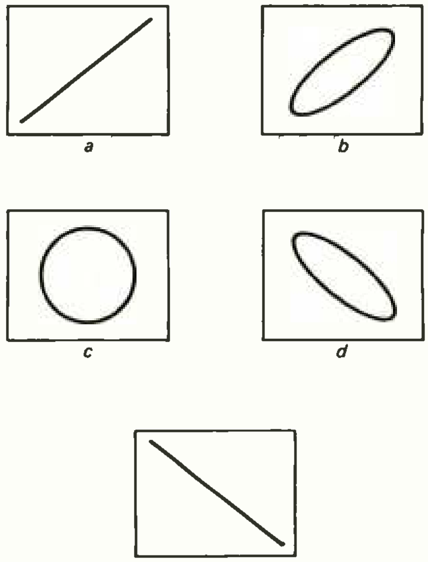
This technique does determine that the frequency difference is less than a certain amount. Such a technique is frequently used for setting oscillator frequencies within a certain tolerance. The upper-frequency limit of this technique is dependent on the reference frequency available and the horizontal frequency capability of the oscilloscope.

The Lissajous technique may be expanded to measure frequency ratios. Figure 21-a shows the pattern created when the vertical frequency is twice that of the horizontal frequency. Figure 21-b shows the opposite case, where the horizontal frequency is twice that of the vertical frequency. Fairly complex frequency ratios may be measured by this technique, but as the ratios grow larger, it is more difficult to maintain sufficient pattern stability long enough to determine the ratio. For most cases, limits of 5 to 1 are fairly reasonable. Lissajous patterns do represent a fairly realistic form of frequency measurement. The 60 cycle power line provides a reference with frequency stability in the order of .1 to .01%. *(continued on page 86)*



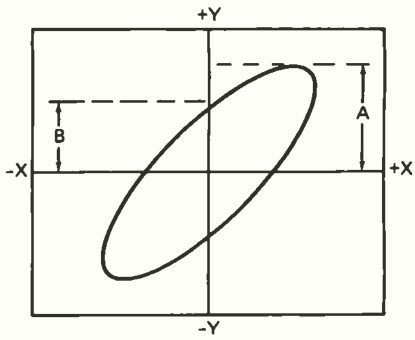
a b

FIG. 21—LISSAJOUS PATTERNS for a two-to-one frequency relationship between horizontal and vertical signals.



a b c d e

FIG. 22—LISSAJOUS PATTERNS FOR (a) 0°, (b) 45°, (c) 90°, (d) 135°, and (e) 180°.



$$\theta = \text{ARC SIN} \frac{A}{B}$$

FIG. 23—PHASE ANGLE measurement. The X and Y amplitudes must be equal for the relationship to hold.

State of SOLID STATE

This month we will look at a monolithic power amplifier and a monolithic function generator.

by KARL SAVON
SEMICONDUCTOR EDITOR

THE INTEGRATED-CIRCUIT AUDIO POWER amplifier has been kicking around for a few years now. It's only recently though, that the full potential of the IC has been used. The beauty of the latest circuits is that they have effective burn-out protection built right in. They are *nearly* impossible to destroy. Nearly, because there is always someone who with seemingly little effort can do the impossible. Even though an amplifier is protected against shorts and elevated temperature, it can never be protected against excessively high power supply voltage. If a power supply is connected to an IC terminal and the control knob turned high enough, something is going to break down and pfft, there goes the IC. Cooking an amplifier chip beyond the maximum allowable junction temperature with an outside heat source is another way to destroy it.

When a manufacturer says an amplifier is fully protected, he means it will not be destroyed within the bounds of reasonable, sometimes unstated common sense qualifications. Usually the conditions are listed under the absolute maximum ratings. And if you expect 7 watts of audio out of a 14- or 16-pin dual-in-line package, and you forget to attach it to a large enough heat sink, the amplifier may not burn out, but neither will it amplify.

The nice thing about self-protected amplifiers is that you don't have to get carried away overdesigning heat sinks to protect against what might happen under abnormal conditions.

SGS-ATES 10-watt fully protected amplifier

The TCA940 monolithic power amplifier is perfect for low-cost stereo, tape recorder and radio applications. It typically delivers 10 watts into 4 ohms, but at 10% distortion. A more practical rating is 7 watts into 4 ohms at 1% THD. Working into an 8-ohm load the power output for 1% distortion is about 5 watts.

Two separate protection systems are built into the chip. One responds to accidents, the kind that happen when your screwdriver shorts the amplifier output terminals. You knew you shouldn't have been working with the amplifier turned on, but then you are a meticulously careful worker. . . . The other guards against the longer lasting problem, like external component failure. It reacts to chip overheating.

A short-circuit protection circuit limits the peak current in the output transistors. The schematic diagram in Fig. 1 doesn't show the protection circuit details but shows a limiting circuit block connected across both the upper and lower output transistors Q14 and Q15. They are also connected in series with the bases of pull-down devices Q12 and Q16. In most IC audio amplifiers only the upper output transistor is protected. It is the one subjected to the most abuse.

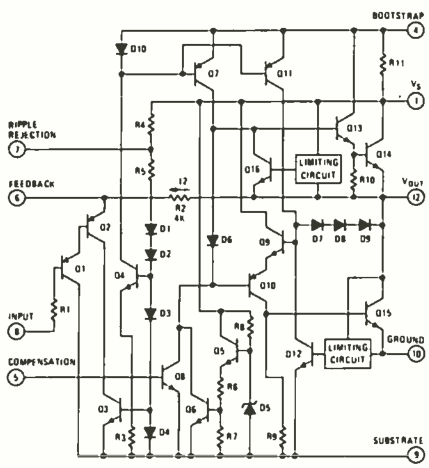


FIG. 1—TCA940 SCHEMATIC DIAGRAM. V_{out} is biased at precisely $V_s/2$.

The usual output short is to ground and it is the upper transistor that is overloaded. The lower transistor limiting circuit in the TCA940 gives protection against shorting the output terminal to the power supply. Shorts on the speaker side of the output coupling capacitor will also overload Q15. Trying to force the output voltage to follow a decreasing input swing, the lower output transistor attempts to absorb the large amount of charge on its now purely capacitive load.

The only other thing known about the limiting circuit is that it controls peak power. As the collector-to-emitter voltage across either output transistor increases, the limiting current decreases. Fig. 2 shows this characteristic. At 7 volts, the limiting current is 2.6 amps, and the power is 7 × 2.6 = 18.2 watts. At 14 volts, the limiting current is 1.4 amps, and the power is 14 × 1.4 = 19.6 watts, pretty much the same. I know 19 watts is much higher than the 8-watt absolute maximum power dissipation rating of the TCA940.

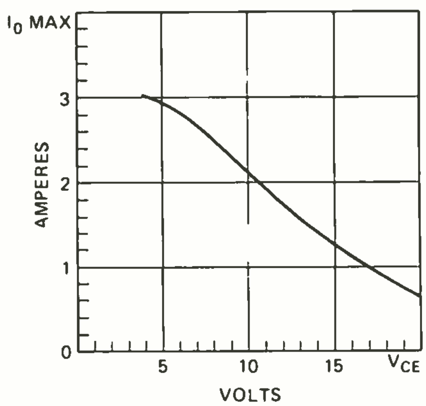
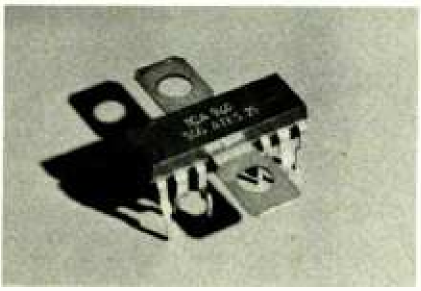


FIG. 2—GRAPH FOR THE TCA940 shows the current limiting vs. collector voltage.

Remember though, that this is a short-circuit protection scheme. It limits the peak dissipation of the output transistors to prevent destruction of the transistors before the chip temperature has had time to change. It protects against failure due to local destruction of the devices or the metalization. The circuit has thermal capacitance, the ability to soak up short bursts of peak energy. The transient-power capability of the circuit is much greater than its steady-state limitations.

If the overload is continuous or has a high duty cycle, the temperature of the chip rises rapidly and the second



SGS-ATES TCA940 monolithic power amplifier delivers 10 watts into 4 ohms.

protection system comes into play. With a 4-ohm load and 110°C chip temperature, the power output is sharply restricted, and it is completely shut down if the temperature gets as high as 125°C. The protection knee and final shutdown temperatures increase to 125°C and 135°C when working into 8 ohms. Q6 is the temperature sensing transistor which is located close to the output transistors. Zener D5 and emitter follower Q5 bias the base of Q6 through resistor divider R6-R7 at a voltage which is below the turn-on threshold of Q6.

The base-to-emitter junction voltage of a silicon transistor has a negative temperature coefficient; the turn-on threshold reduces at about 2-mV per °C. When the chip warms up, Q6 will turn on as its threshold voltage decreases below the voltage across R7. The collector current in Q6 pulls down

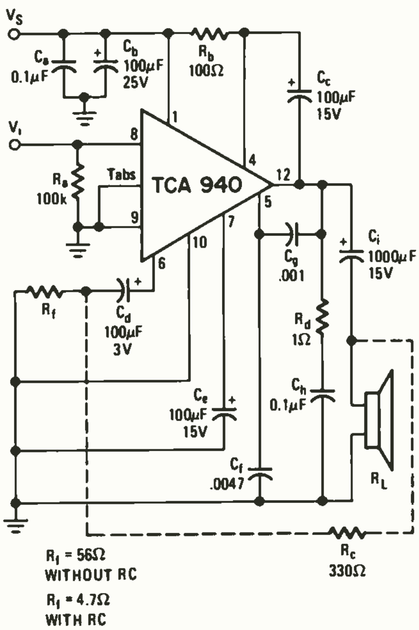


FIG. 3—TCA940 IN AUDIO AMPLIFIER application. Resistor R_c is connected for gain stabilization.

the drive to the base of output driver Q13 through D6.

Figure 3 shows the IC connected to the external components and power supply making a complete audio amplifier. C_f and C_g are frequency compensation capacitors. C_f is five times C_g's value and C_g's capacitance depends on the bandwidth and the AC coupled feedback resistor R_f. A graph on the data sheet gives the component values.

In the schematic (see Fig. 1) you can see R2, a 4K resistor, connected between the output pin 12 and the pin 6 feedback emitter of Q2. The typical open-loop gain of the amplifier is 75 dB or about 5600 times. For normal closed-loop gain in the range of 40 dB, the gain can be calculated by taking the inverse of the feedback factor $R_f/(R_f + R2)$ which is $1 + R2/R_f$. R2 has a tolerance of ±30% plus a positive temperature coefficient of 0.2% per degree C.

The gain of the amplifier changes almost as the resistor does. If better gain stability is needed, an external resistor can be connected from the feedback resistor to the output load, shown by the dotted lines in Fig. 3. The added resistor R_c shunts the internal R2 lowering the parallel combination of the two. Choosing the external resistor at least ten times smaller than R2 makes the gain mostly dependent on the ratio of R_f and R_c.

To keep the gain up when the low external series feedback resistor is used, the value of R_f must also be lowered. Adding R_c gives a gain stability of ± 1dB. Cd, the 100 µF DC blocking capacitor, keeps the DC feedback from being affected by manipulations in AC feedback components. Notice that the amplifier does not have a differential input stage arrangement. The internal biasing of the amplifier sets the DC output at pin 12 at precisely one-half of the power supply voltage. Input terminal 8 is returned to ground through a 100K resistor. Since the bias current in the base of Q1 is only 0.5 µA, the drop across the resistor is negligible and the base can be considered grounded. One end of R2 is returned to V_{out} and the other is 2 V_j (junction-voltage-drops) above ground because of the series aiding Q1-Q2 base-emitter junctions. V_j is the nominal 0.7 volt PN junction voltage.

The current in R2 is then $I2 = (V_{out} - 2V_j)/R2$. I2 flows through Q2 into Q3. The current in Q3 is the same as the current in D4 which is $(V_s - 4V_j)/(R4 + R5)$. Setting $V_{out} = V_s/2$ we get: $(V_s/2 - 2V_j)/R2 = (V_s - 4V_j)/(R4 + R5)$ Multiplying the top and bottom of the left hand expression by 2: $(V_s - 4V_j)/2R2 = (V_s - 4V_j)/(R4 + R5)$ and the necessary biasing condition is: R4 + R2 = 2R2 and R2 = R4 = 4000 ohms.

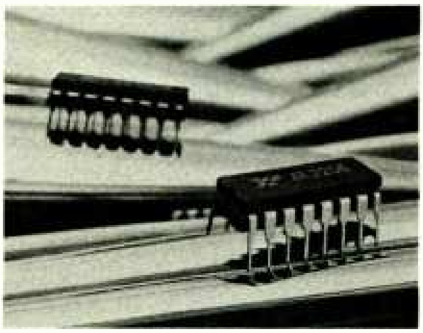
R_d and C_h is a Boucherot Cell for high-frequency stability, and bootstrap coupling capacitor C_e raises the input impedance to the upper output transistor to keep the upper part of the output waveform symmetrical.

The TCA940 is mounted in a 12-pin dual-in-line plastic package with two large tabs that conduct heat from the chip to an external heat sink. SGS-ATES calls it the FIN DIP package. In small quantities the TCA940 costs $5.25 each.

More information including a printed board layout is available from SGS-ATES Semiconductor Corp., 435 Newtonville Avenue, Newtonville MA 02160.

EXAR monolithic function generator

A function generator is a versatile general-purpose signal source. It has a choice of output waveforms including sine wave, square, pulse and triangle signals. The linear triangle wave is



EXAR'S XR2206C FUNCTION GENERATOR is capable of AM, FM, FSK, and PSK.

great for checking amplifier linearity or measuring triggering points of level sensitive trigger circuits. Sine waves of course are the common denominator source for most frequency and distortion measurements. Pulse and square waves give quick checks on transient response. Did you ever wish you could check a TV yoke but you didn't own a yoke tester, well I have. Drive the yoke from the pulse output of a waveform generator through an isolating resistor. The damped response displayed on a scope will tell you the condition of the coils.

The heart of modern function generators is a wideband voltage-controlled oscillator or VCO. One type of oscillator linearly charges and discharges a capacitor with constant current sources and sinks. Square and pulse waveforms are byproducts of this oscillator; they are used to switch between the charge and discharge cycles. Emitter-coupled astable oscillators with current source emitter loads are popular forms of this oscillator.

Curve fitting techniques using diodes to sense levels on the triangle wave is the basis on one method of sine wave conversion. A sine wave can be constructed from straight line segments of different slopes. Surprisingly few breakpoints are needed to produce low-distortion sine waves. The gradual exponential cutoff response of a partially degenerated differential amplifier is a method more suitable to IC techniques.

Another way of doing it is to start with a sine wave. Two integrating amplifiers in a closed loop is the basic hook-up. Analog multipliers inserted between the amplifiers give a means of frequency control.

Still a third method is to digitally generate a staircase or other stepped function from a binary counter. Digital-to analog-converters then complete the signal processing by putting together the desired waveshapes.

A second auxiliary oscillator adds flexibility to the function generator as a frequency sweeper or burst gater.

The IC function generator replaces a lot of expensive and complicated circuitry. Most of the needed circuitry to build a precision function generator is on the EXAR XR-2206C chip. It is capable of AM, FM, FSK, and PSK. It can be used as the VCO element in a phase-locked loop.

The diagram in Fig. 4 shows the four

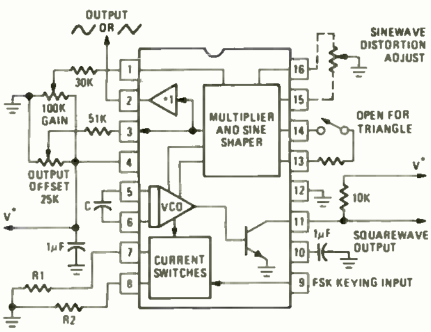


FIG. 4—EXAR'S XR2206C FUNCTION GENERATOR has four basic elements.

basic elements of the EXAR chip. Integrated circuits have excellent current matching capabilities but are rather poor in absolute tolerances. External parts are used for the frequency determining elements for the RC oscillator. A 0.01 to 100 μF timing capacitor is connected between IC terminals 5 and 6. Resistors between 1K and 2 megohms connected to pins 7 and 8 complete the frequency determining network. EXAR uses the emitter-coupled oscillator type. Either of the two resistors is selected by the current switch controlled from the frequency-shift keying input, pin 9. Mark and space FSK frequencies can be generated by feeding pin 9 with a digitally coded modulation signal. The oscillator frequency is equal to 1/RC. The current out of the selected terminal can be controlled by a voltage applied through a resistor network to change the frequency. Pins 7 and 8 are low-impedance circuit points biased internally to about +3 volts. Oscillator frequency is expressed in terms of the control current and the value of the capacitor: $f = 0.320I/C$. The frequency range is 0.01 Hz to 0.5 MHz minimum. The typical high-frequency limit is 1 MHz.

The sweep range of the oscillator is 2000 to 1. With a 10:1 frequency sweep, the sweep linearity is 2%. A wider 1000:1 sweep range gives 8% linearity. Depending on the choice of resistor value, the temperature stability is typically ±20% parts-per-million per degree centigrade between 0 and 75°C. Supply sensitivity is also excellent, 0.01%/V. VCO outputs feed the multiplier and sine shaper. Sine shaping is done by the differential amplifier method. Square and pulse shaped outputs are derived from another VCO output. Pin 1 is the amplitude modulation input. The output is linearly controlled by variations of the pin 1 voltage around $V^+/2$. The signal output at pin 2 is 0 when the pin 1 voltage is half the supply. Above $V^+/2$, the output increases. Voltages below $V^+/2$ increase the output amplitude but with opposite phase. Double sideband modulation and phase shift keying can be generated using this input. Carrier suppression is 55 dB with double sideband. 100% amplitude modulated signals are generated with 2% linearity up to the 95% modulation point. The pin 2 output is buffered from the sine shaper by a unity gain amplifier.

Output waveform symmetry is adjusted by a resistor between terminals 13 and 14. An open connection between the terminals gives a triangle output at pin 2. Distortion is optimized by connection and adjustment of a 25K grounded potentiometer between pins 15 and 16. Typical distortion is 2.5% without the adjustment and 0.5% with.

Variable duty cycle pulses and sawtooths are generated by tying pins 9 and 11 together. The oscillator will automatically switch from one time determining resistor to the other on each oscillator half cycle. The differing half-cycle periods produce a non-symmetrical pulse. The triangular output at pin 2 will also be non-symmetrical or sawtooth shaped.

The XR2206C operates from dual ±5 to ±13 volt or single 10 to 26 volt power supplies. It is priced at $5.50 in small quantities.

EXAR also markets an older type the XR-205. The 205 does not have the current switch or the 2000:1 sweep range of the 2206 but has wider frequency coverage to 4 MHz. It is only available in a prime version and is more expensive than the commercial version of the 2206. The 2206 has the lower sine distortion and better triangle linearity of the two chips.

For further information contact R-OHM Corporation, EXAR Integrated Systems, P.O. Box 4455, Irvine, California 92664.

Panasonic bucket brigade device

Matsushita Electronics Corporation has announced the MN-3001, a dual 512 stage BBD. Using P-channel silicon-gate processing, the device is built from a chain of tetrode MOS transistors and MOS capacitors. These devices form an analog shift register where time sampled voltages are transferred down the string of capacitors.

You probably have seen some news items on variable speed tape recording systems, ones in which the playback speed is adjustable without a change in apparent voice tone and with no loss of intelligibility. An electrical delay line is the system's basic element. Bucket brigade delay lines will also be used for audio reverberation effects, electronic organ chorus and vibrato effects and radio security scrambling systems.

The two 512 element delay lines connected in series give a maximum time delay of 51.2 milliseconds when clocked at a 10 kHz rate. When hooked in parallel the output voltage is doubled.

The MN-3001 operates from 0—15 volts and clock frequencies of 10 to 800 kHz.

New quad timers

First there were dual and quad op-amps. Now we have the Quad Timer. The Signetics NE/SE 553 and 554 have four timers on a chip with monostable time delays from microseconds to hours. Monolithic timers are used for time interval generators, sequential timing and pulse modulation. I have never seen as many design ideas in the electrical engineering magazines applied to any other type device with the exception of the op-amp. An external resistor and capacitor determines the time delay.

Both devices have current output capabilities of 100 mA. The difference between the 553 and 554 is that the first sinks current and the second sources current. The timers are both edge triggered. No coupling capacitors are needed in sequential applications where the timers are chained.

They are packaged in 16 pin dual-in-line plastic and operate from 4.5 to 16 volts. **R-E**

Step-by-step TV Troubleshooters Guide

Color problems are not difficult if you follow a logical step-by-step troubleshooting procedure and circuit analysis.

by STAN PRENTISS

THE TWO PROBLEMS THAT STUMP SERvice technicians the most are undoubtedly high voltage and *color.* Either one is solvable with a little patience, proper circuit analysis, and *good* test equipment. For instance, if a color receiver is hybrid or all tubes, the horizontal output tube drive voltage will have an exponential shape and usually measure about 250 volts AC. A transistorized horizontal output stage, being current driven, will have a rectangular shaped voltage, probably with a few transient spikes, and an amplitude of perhaps 10 volts fully loaded as it passes through the inevitable current-driver transformer to the base of the horizontal output transistor. If there is no high voltage and the drive waveforms are good, or the luminance section isn't driving the picture tube to cutoff, then the problem is with the horizontal output tube or transistor, a B-boost or shunt capacitor, the deflection yoke, or possibly the flyback transformer itself. Standard voltage and waveform checks will usually isolate the trouble. At the moment, however, we've got a color problem. The problem is not to difficult to solve if handled systematically.

When color comes & goes

The complaint on this Sears 562.-10481 amounted to the simple statement that the "color comes and goes." And, indeed, a look at the picture tube with an on-the-air colorcast confirmed the obvious: color most assuredly came and went, and even when it remained for a few minutes, the color control could, by no means, produce saturation. Tint responded reasonably well well but would not phase fully from flesh tones through green and magenta. So here were a pair of puzzlers worth attention.

A schematic of the chroma section is shown in Fig. 1. There's an L501 chroma takeoff coil—centertapped for better impedance matching; a pair of chroma bandpass transistor amplifiers (Q501, Q502) their transformers (T501-T502) plus burst and the subcarrier oscillator. Of course there are the usual demodulators and RGB-Y outputs in this hybrid receiver but, in this instance they are eliminated from our search by immediate voltage checks and prompt tube substitutions. There was a slight increase in overall waveform amplitude, but nothing worthwhile, and cathode, grid, and plate potentials were well within the 10–15% tolerance. So it's back to the chroma and color sync circuits for investigation and analysis. And since these are basically transistor ***amplifiers,*** the only real way to do this is by examining signal passage, beginning with the 8KR8 (V201-a) video amplifier. First, however, I decided to do something a little different—and that was to quickly decide whether the problem is in the subcarrier portion of the color

TROUBLESHOOTING CHART (color problems)

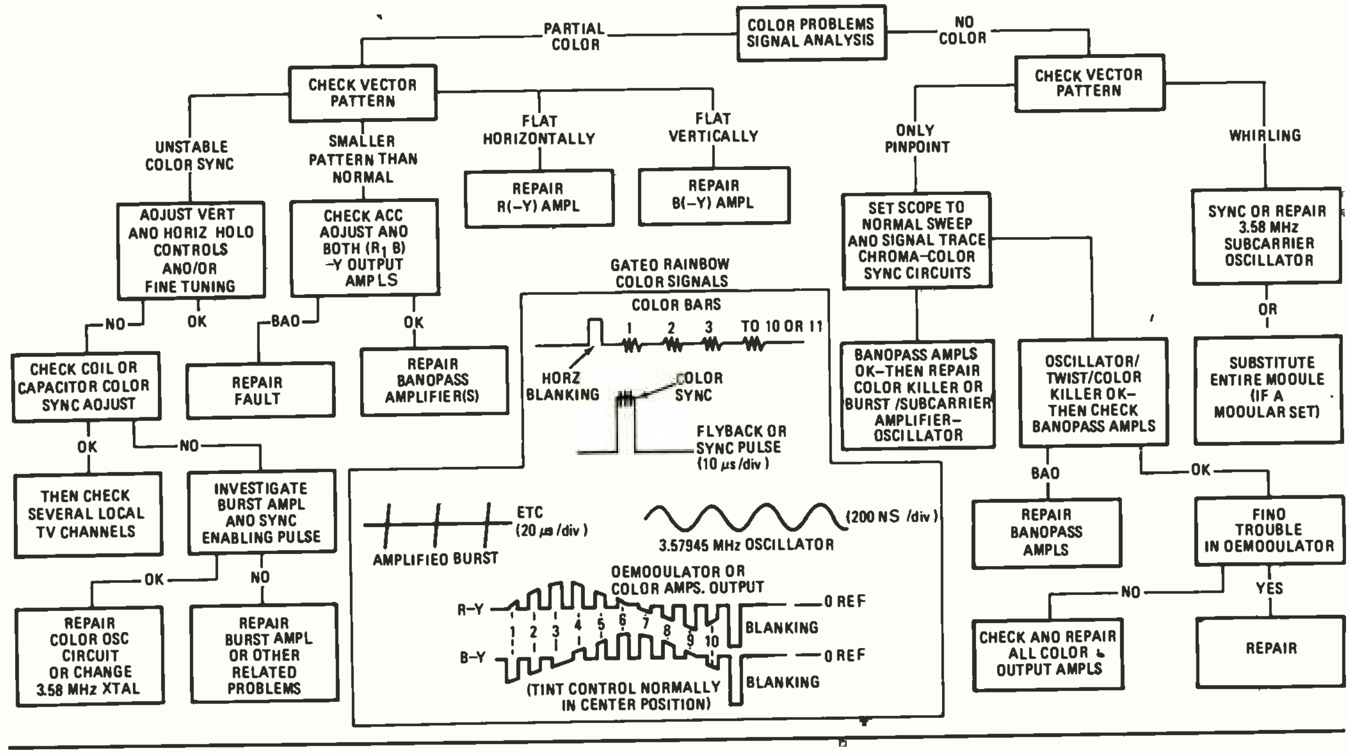
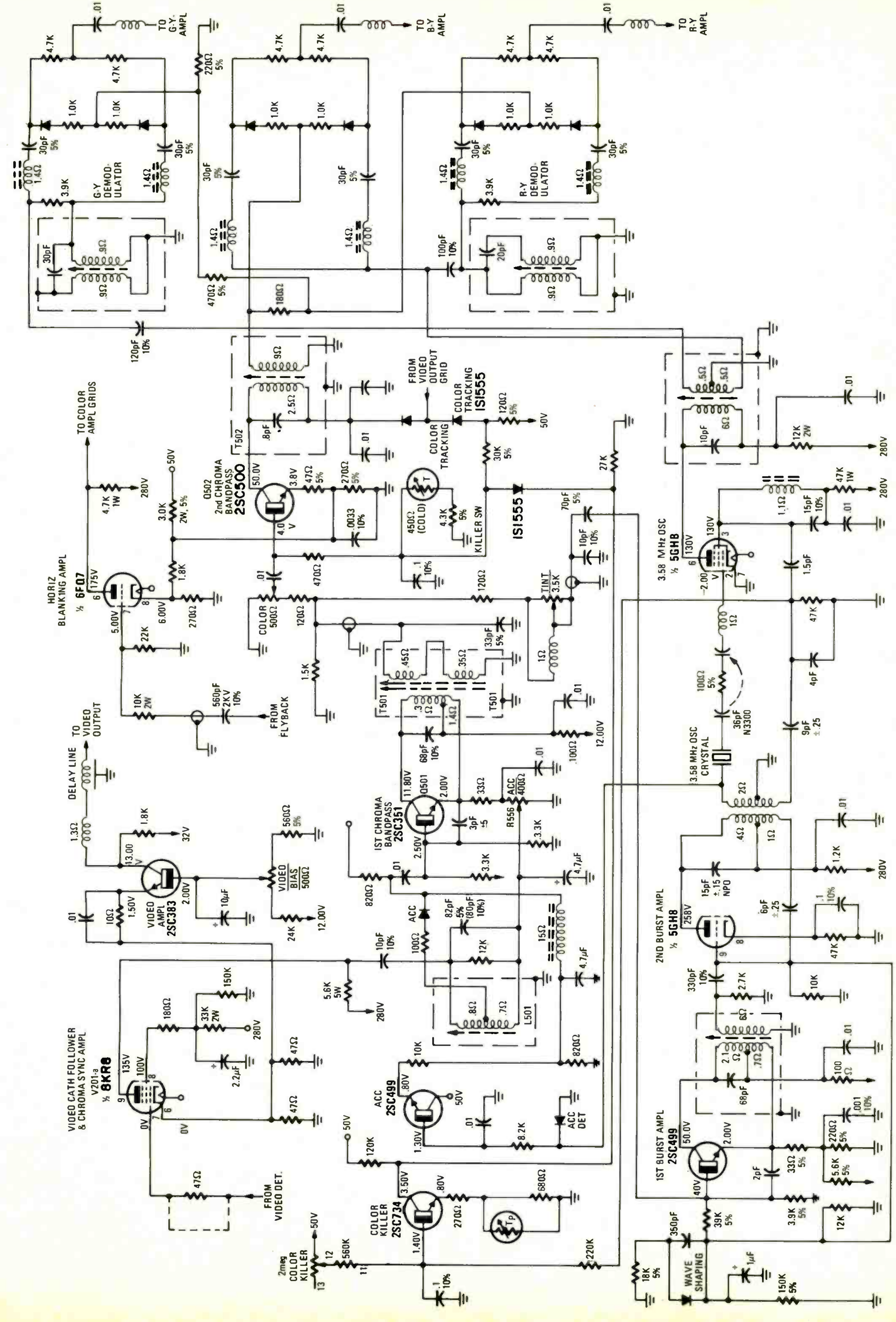


FIG. 1—SEARS MODEL 562.10481 hybrid color television receiver.



circuits or in the bandpass amplifiers.

Identifying the problem

So why not hook up a dual-trace oscilloscope at the R-Y and B-Y grids of the picture tube, put a *clean* color bar signal through the tuner, and see what the Y-Y (some say X-Y) vector pattern (Fig. 2) looks like. Since, with this method, you can actually see the entire operation of the chroma circuits. Therefore, with the scope's vertical amplifiers set for 20 volts/division, the pattern is very small, has lots of looped petals in the wrong places, and the blanking pulse is smeared. True, some of these contortions can be forced with misadjusted fine tuning, but that isn't our basic problem. The chroma amplifiers, themselves, are adding to the collective woes with low voltage output, although the subcarrier oscillator remains steady and in sync. Out of sync, the patterns spin, and if the color oscillator quit, there would be no vector pattern at all. Now both output amplifiers seem to be operating satisfactorily because neither the red vertical nor blue horizontal portions are affecting the small but relatively stable oval display. So our problem really becomes threefold: we want to straighten up the pattern with fine tuning, troubleshoot the chroma *amplifiers*, probably re-align the chroma amplifiers and touch-up the burst transformer for at least an overall 70-degree phase shift. This really isn't as difficult as it sounds —so let's go.

Signal analysis

With a 2-volt input into the 8KR8 chroma-sync amplifier from the video detector—as specified by the schematic—you want maximum swing from the plate of V201a to drive the 1st chroma bandpass transistor Q501. So a new 8KR8 (if this one's an original) often helps. The ACC potentiometer R556 can next be adjusted for Q501 maximum output. Now, if these changes don't do the trick, and the vector pattern hasn't expanded considerably in all directions, return the scope to normal operation and go after both bandpass amplifiers.

Since the input signal at the base of Q501 is only 30 mV and that at the base of second chroma bandpass amplifier Q502 has no visible amplitude, let's go to the *collectors* of both transistors and look at the AC waveforms as well as the DC levels simultaneously. The upper trace of Fig. 3, shows an amplitude of less than 1 volt at the collector of Q501, but with a normal DC collector operating potential of some 11 volts. There's about the same condition at the collector of Q502, shown in the lower trace of Fig. 3. Here the scope's vertical setting amounts to 10 volts/division, and exhibits an AC amplitude of a little over 8 volts, with

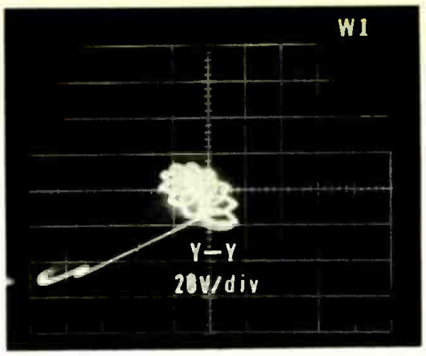


FIG. 2—POOR VECTOR PATTERN and distorted blanking bar was taken with a sensitivity of 20 V/div including the X10 attenuation of the low-capacity probes.

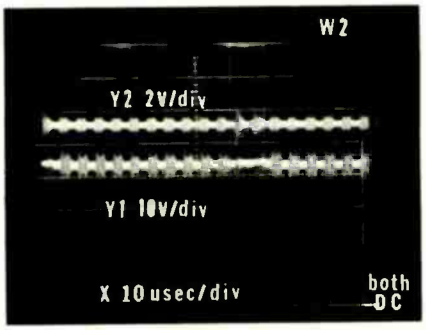


FIG. 3—COLLECTOR WAVEFORM of transistor Q502 is shown in the upper trace. Lower trace shows the waveform at the collector of Q501.

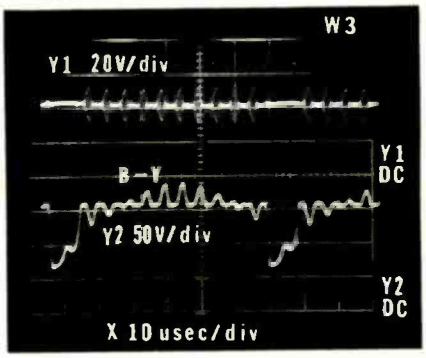


FIG. 4—NORMAL WAVEFORM at the collector of Q502 is shown in upper trace. Normal B-Y waveform is shown in lower trace.

a DC output of 45 volts. There are also DC readings of 5.9 volts at the base and 5.2 volts at Q502's emitter. These "slightly-off" base-emitter measurements, however, are nothing to become excited about since you don't know either the accuracy of the original meter readings, or whether a low impedance shunt may have taken place when the meter—whatever it was—was connected across the lower junctions of the transistor. But collector readings are usually pretty well on target, with one outstanding exception: instead of Q502's collector amplitude being 20 volts AC as specified, the output is less than half, even with bandpass transformer T502 impedances included. So, both the first and second chroma bandpass amplifiers—as the vectorscope indicated—seem to have AC problems.

Of course, it could be worse. For the most part, DC voltages are holding, so the power supplies are fine, and passive components such as bypass and coupling capacitors, resistors, and transformers are doing their filtering, signal flow, and impedance matching jobs. A quick ohmmeter shunt across the color control—with the set off, of course—verifies there are no problems here. Consequently, there remains but one principal action to take, and that is change one or both transistors since apparently there is leakage.

Cleaning up

Cross referencing the 2SC351 and 2SC500 in the transistor stock lists produces substitutes. Now, there's little to do but wick off all old solder about the original units with a 40-watt iron and some braid, and the new semiconductors are ready for insertion. This is easily done when the chassis bottom screws have been removed, along with the paper side chassis insulator. When both transistors are soldered securely, and *(continued on page 76)*

R-E's Substitution guide for replacement transistors

PART XXIX

by ROBERT & ELIZABETH SCOTT

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

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

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

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

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

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

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

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

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

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

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

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

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

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2S351B	NA	NA	NA	NA	TR-17	PTC 107	NA	NA	RT-183	ECG 160	NA	NA
2S363	NA	NA	GE-20	NA	TR-21	PTC 136	NA	NA	RT-114	ECG 123A	NA	NA
2S375	NA	NA	NA	NA	NA	PTC 109	NA	NA	NA	ECG 102	NA	NA
2S381	NA	NA	NA	NA	TR-21	NA	NA	NA	RT-107A	ECG 123A	NA	NA
2S471-1	NA	NA	GE-50	NA	TR-17	PTC 107	NA	NA	RT-183	ECG 160	NA	NA
2S494	NA	NA	NA	NA	NA	NA	NA	SK 3114	RT-115	ECG 159	NA	NA
2S501	RS276-2009	T-50	GE-61	ICC-50	TR-21	PTC 139	HEP-50	SK 3122	RT-102	ECG 123A	WEP 736	ZEN 100
2S502	RS276-2009	T-50	GE-61	ICC-50	TR-21	PTC 139	HEP-50	NA	RT-102	ECG 123A	WEP 736	ZEN 100
2S503	RS276-2009	T-50	GE-62	ICC-50	TR-21	PTC 139	HEP-50	SK 3122	RT-102	ECG 123A	WEP 736	ZEN 100
2S512	RS276-2023	T-52	GE-20	ICC-52	TR-53	PTC 133	HEP-52	SK 3039	RT-113	ECG 108	WEP 56	NA
2S608	NA	NA	NA	NA	TR-21	NA	NA	NA	RT-107A	ECG 123A	NA	NA
2S644	NA	NA	GE-16	NA	TR-51	NA	NA	NA	RT-127A	NA	NA	NA
2S701	RS276-2021	T-51	GE-60	ICC-51	TR-53	PTC 132	HEP-51	SK 3124	RT-100	ECG 123	WEP 53	ZEN 101
2S702	RS276-2021	T-51	GE-60	ICC-51	TR-53	PTC 132	HEP-51	SK 3124	RT-100	ECG 123	WEP 53	ZEN 101
2S703	RS276-2021	T-51	GE-60	ICC-51	TR-53	PTC 115	HEP-51	SK 3124	RT-100	ECG 123	WEP 53	ZEN 101
2S711	RS276-2009	T-53	GE-18	ICC-53	TR-25	PTC 125	HEP-53	SK 3124	RT-100	ECG 123	WEP 53	ZEN 102
2S712	RS276-2009	T-53	GE-18	ICC-53	TR-25	PTC 125	HEP-53	SK 3124	RT-100	ECG 123	WEP 53	ZEN 102
2S731	RS276-2023	T-52	GE-17	ICC-52	TR-25	PTC 101	HEP-52	SK 3122	RT-102	ECG 123A	WEP 53	NA
2S732	RS276-2023	T-52	GE-17	ICC-52	TR-25	PTC 101	HEP-52	SK 3122	RT-102	ECG 123A	WEP 53	NA
2S733	RS276-2023	T-52	GE-17	ICC-52	TR-65	PTC 101	HEP-52	SK 3122	RT-102	ECG 123A	WEP 53	NA
2S741	RS276-2021	T-51	GE-11	ICC-51	TR-87	PTC 139	HEP-51	SK 3024	RT-114	ECG 128	WEP 243	ZEN 101
2S742	RS276-2021	T-51	GE-63	ICC-51	TR-87	PTC 117	HEP-51	SK 3024	RT-114	ECG 128	WEP 243	ZEN 101
2S743	NA	NA	GE-18	NA	TR-78	PTC 117	NA	SK 3045	RT-110	ECG 154	WEP 712	NA
2S744	RS276-2021	T-51	GE-11	ICC-51	TR-87	PTC 139	HEP-51	SK 3025	RT-114	ECG 128	WEP 243	ZEN 101
2S745	RS276-2021	T-51	GE-63	ICC-51	TR-87	PTC 117	HEP-51	SK 3024	RT-114	ECG 128	WEP 243	ZEN 101
2S746	NA	NA	GE-18	NA	TR-78	PTC 117	NA	SK 3045	RT-110	ECG 154	WEP 712	NA
2S828(Q)	NA	NA	NA	NA	TR-21	NA	NA	NA	RT-107A	NA	NA	NA
2S838(E)	NA	NA	NA	NA	TR-724	NA	NA	NA	NA	NA	NA	NA
2S930C	NA	NA	NA	NA	TR-51	NA	NA	NA	RT-172	ECG 160	NA	NA
2S930(D)	NA	NA	NA	NA	TR-51	NA	NA	NA	RT-172	NA	NA	NA
2S930(E)	NA	NA	NA	NA	TR-24	NA	NA	NA	RT-114	ECG 108	NA	NA
2S945	NA	NA	NA	NA	TR-21	NA	NA	NA	RT-107A	ECG 123A	NA	NA
2S1014D1	NA	NA	NA	NA	TR-76	NA	NA	NA	RT-197	ECG 152	NA	NA
2S1760	NA	NA	GE-2	NA	NA	NA	NA	NA	RT-123	ECG 102	NA	NA
2S3010	NA	T-715	GE-21	ICC-715	TR-88	NA	HEP-715	SK 3025	RT-115	ECG 129	WEP 242	ZEN 106
2S3020	NA	T-715	GE-21	ICC-715	TR-52	NA	HEP-715	SK 3114	RT-115	ECG 159	WEP 717	ZEN 106
2S3021	NA	T-52	GE-22	ICC-52	TR-52	NA	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2S3030	NA	T-722	GE-22	ICC-722	TR-52	NA	HEP-722	SK 3114	RT-115	ECG 159	WEP 717	ZEN 110
2S3040	NA	T-717	GE-22	ICC-717	TR-52	NA	HEP-717	SK 3114	RT-115	ECG 159	WEP 717	NA
2S3187	NA	NA	NA	NA		PTC 102	NA	NA	NA	NA	NA	NA
2S3210	RS276-2023	T-52	GE-21	ICC-52	TR-52	NA	HEP-52	SK-3114	RT-115	ECG 159	WEP 717	NA
2S3220	RS276-2023	T-52	GE-21	ICC-52	TE-52	NA	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2S3221	RS276-2023	T-52	GE-22	ICC-52	TR-20	NA	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2S3230	RS276-2023	T-52	GE-22	ICC-52	TR-52	NA	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2S3240	RS276-2023	T-52	GE-22	ICC-52	TR-52	NA	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2S3324	NA	NA	NA	NA	TR-05	PTC 102	NA	NA	NA	ECG 105	NA	NA
2S3370	NA	NA	GE-52	NA	TR-05	PTC 102	NA	NA	RT-123	ECG 105	NA	NA
2S3734Y	NA	NA	NA	NA	TR-87	NA	NA	NA	RT-187	ECG 128	NA	NA
2S6344	NA	NA	NA	NA	TR-21	NA	NA	NA	RT-107A	ECG 123A	NA	NA
2S6371	NA	NA	NA	NA	TR-21	NA	NA	NA	RT-107A	ECG 123A	NA	NA
2S6387	NA	NA	NA	NA	TR-83	NA	NA	NA	NA	NA	NA	NA
2S6856	NA	NA	NA	NA	NA	NA	NA	SK 3040	RT-110	ECG 154	NA	NA
2SA01	NA	NA	NA	NA	TR-11	NA	NA	NA	NA	NA	NA	NA
2SA12	RS276-2004	T-253	GE-50	ICC-253	TR-12	PTC 109	NA	SK 3005	RT-123	ECG 102A	WEP 250	ZEN 304
2SA12(D)	NA	T-253	NA	NA	TR-12	PTC 109	HEP-253	NA	RT-123	ECG 158	NA	NA
2SA12A	RS276-2004	T-253	GE-1	ICC-253	TR-12	PTC 109	NA	SK 3006	RT-188	ECG 102A	WEP 250	ZEN 304
2SA12B	NA	T-253	GE-50	ICC-253	TR-12	PTC 109	HEP-253	SK 3008	RT-123	ECG 102A	WEP 250	ZEN 304
2SA12C	RS276-2004	T-253	GE-1	ICC-253	TR-85	PTC 109	HEP-253	SK 3006	RT-188	ECG 102A	WEP 250	ZEN 304
2SA12D	NA	T-254	GE-50	ICC-254	TR-85	PTC 109	HEP-254	SK 3006	RT-188	ECG 102A	WEP 250	ZEN 305
2SA12H	RS276-2004	T-250	GE-50	ICC-250	TR-85	PTC 109	HEP-250	NA	RT-123	ECG 102A	WEP 250	ZEN 302
2SA12V	NA	T-253	NA	ICC-253	TR-12	PTC 109	HEP-253	SK 3006	RT-188	ECG 102A	WEP 250	ZEN 304
2SA13	RS276-2004	T-250	GE-50	ICC-250	TR-17	PTC 109	HEP-250	SK 3005	RT-183	ECG 160	WEP 637	ZEN 302
2SA14	RS276-2004	T-250	GE-1	ICC-250	TR-17	PTC 109	HEP-250	SK 3005	RT-183	ECG 160	WEP 637	ZEN 302
2SA15	RS276-2004	T-250	GE-50	ICC-250	TR-85	PTC 107	HEP-250	SK 3005	RT-123	ECG 102A	WEP 250	ZEN 302
2SA15-6	NA	NA	NA	NA	NA	PTC 107	NA	SK 3005	NA	ECG 100	NA	NA
2SA15H	RS276-2004	T-250	GE-50	ICC-250	TR-85	PTC 109	HEP-250	NA	RT-123	ECG 102A	WEP 250	ZEN 302
2SA15R	NA	NA	NA	NA	TR-05	PTC 107	NA	SK 3005	RT-117	ECG 100	NA	NA
2SA15V	RS276-2003	T-635	GE-1	ICC-250	TR-17	PTC 107	HEP-250	SK 3005	RT-118	ECG 100	WEP 254	ZEN 311
2SA15V/ R	NA	T-253	NA	ICC-253	TR-85	PTC 107	HEP-253	SK 3005	RT-117	ECG 100	WEP 254	ZEN 304
2SA15Y	NA	T-635	GE-2	ICC-635	TR-85	PTC 107	HEP-635	SK 3005	RT-123	ECG 102A	WEP 250	ZEN 302
2SA16	RS276-2004	T-250	GE-50	ICC-250	TR-85	PTC 107	HEP-250	SK 3005	RT-123	ECG 102A	WEP 250	ZEN 302
2SA17	RS276-2021	T-251	GE-1	ICC-251	TR-85	PTC 145	HEP-251	SK 3005	RT-123	ECG 102A	WEP 250	ZEN 303
2SA17H	RS276-2021	T-251	GE-50	ICC-251	TR-85	PTC 109	HEP-251	NA	RT-123	ECG 102A	WEP 250	ZEN 303
2SA18	RS276-2021	T-251	GE-50	ICC-251	TR-85	PTC 109	HEP-251	SK 3005	RT-123	ECG 102A	WEP 250	ZEN 303

NA=NOT AVAILABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2SA18H	RS276-2021	T-251	GE-50	ICC-251	TR-85	PTC 107	HEP-251	NA	RT-123	ECG 102A	WEP 250	ZEN 303
2SA19	RS276-2003	T-639	GE-51	ICC-639	TR-17	PTC 107	HEP-639	SK 3008	RT-119	ECG 126	WEP 635	ZEN 314
2SA20	RS276-2003	T-639	GE-57	ICC-639	TR-17	PTC 107	HEP-639	SK 3008	RT-119	ECG 126	WEP 635	ZEN 314
2SA21	RS276-2003	T-639	GE-51	ICC-639	TR-17	PTC 107	HEP-639	SK 3008	RT-119	ECG 126	WEP 635	ZEN 314
2SA22	NA	NA	GE-51	NA	NA	NA	NA	NA	RT-188	NA	NA	NA
2SA23	NA	NA	GE-51	NA	NA	NA	NA	NA	RT-188	NA	NA	NA
2SA24	NA	NA	GE-50	NA	TR-12	NA	NA	NA	RT-188	NA	NA	NA
2SA25	NA	NA	GE-50	NA	NA	NA	NA	NA	NA	NA	NA	NA
2SA26	RS276-2004	T-250	GE-1	ICC-250	TR-05	PTC 109	HEP-250	SK 3005	RT-118	ECG 100	WEP 254	ZEN 302
2SA27	NA	NA	GE-51	NA	NA	NA	NA	NA	RT-188	NA	NA	NA
2SA28	RS276-2003	T-639	GE-51	ICC-639	TR-17	PTC 109	HEP-639	SK 3005	RT-188	ECG 126	WEP 635	ZEN 314
2SA29	RS276-2003	T-639	GE-51	ICC-639	TR-17	PTC 109	HEP-639	SK 3008	RT-119	ECG 126	WEP 635	ZEN 314
2SA29-3	NA	T-53	NA	ICC-53	NA	NA	HEP-53	NA	NA	NA	NA	NA
2SA30	RS276-2003	T-637	GE-50	ICC-637	TR-17	PTC 107	HEP-637	SK 3005	RT-188	ECG 126	WEP 635	NA
2SA31	RS276-2005	T-254	GE-50	ICC-254	TR-05	PTC 107	HEP-254	SK 3005	RT-118	ECG 100	WEP 254	ZEN 305
2SA32	RS276-2004	T-250	GE-53	ICC-250	TR-85	PTC 109	HEP-250	SK 3005	RT-123	ECG 102A	WEP 250	ZEN 302
2SA33	RS276-2004	T-250	GE-1	ICC-250	TR-85	PTC 109	HEP-250	NA	RT-123	ECG 102A	WEP 250	ZEN 302
2SA35	RS276-2003	T-637	GE-50	ICC-637	TR-85	PTC 109	HEP-637	SK 3005	RT-188	ECG 126	WEP 635	ZEN 305
2SA36	RS276-2003	T-254	GE-50	ICC-254	TR-05	PTC 107	HEP-254	SK 3005	RT-118	ECG 100	WEP 254	ZEN 305
2SA37	RS276-2004	T-250	GE-51	ICC-250	TR-17	PTC 107	HEP-250	SK 3005	RT-188	ECG 126	WEP 635	ZEN 302
2SA38	RS276-2004	T-250	GE-51	ICC-250	TR-17	PTC 107	HEP-250	SK 3005	RT-188	ECG 126	WEP 635	ZEN 302
2SA39	RS276-2004	T-250	GE-51	ICC-250	TR-17	PTC 107	HEP-250	SK 3005	RT-188	ECG 126	WEP 635	ZEN 302
2SA40	RS276-2005	T-254	GE-1	ICC-254	TR-05	PTC 109	HEP-254	SK 3005	RT-118	ECG 100	WEP 254	ZEN 305
2SA41	RS276-2007	T-631	GE-51	ICC-631	TR-17	PTC 109	HEP-631	SK 3005	RT-183	ECG 160	WEP 637	ZEN 307
2SA42	RS276-2007	T-631	GE-51	ICC-631	TR-17	PTC 109	HEP-631	SK 3123	RT-136	ECG 160	WEP 637	ZEN 307
2SA43	RS276-2005	T-638	GE-51	ICC-638	TR-17	PTC 107	HEP-638	SK 3007	RT-188	ECG 126	WEP 635	ZEN 313
2SA44	RS276-2004	T-253	GE-2	ICC-253	TR-05	PTC 102	HEP-253	SK 3005	RT-118	ECG 100	WEP 254	ZEN 304
2SA45	NA	T-635	GE-51	ICC-635	NA	NA	HEP-635	SK 3006	RT-188	ECG 126	WEP 635	ZEN 311
2SA45-1	NA	T-635	GE-51	ICC-635	TR-17	PTC 107	HEP-635	SK 3006	RT-188	ECG 126	WEP 635	ZEN 311
2SA45-2	NA	T-635	GE-51	ICC-635	TR-17	PTC 107	HEP-635	SK 3006	RT-188	ECG 126	WEP 635	ZEN 311
2SA45-3	NA	T-635	GE-51	ICC-635	TR-17	PTC 107	HEP-635	SK 3006	RT-188	ECG 126	WEP 635	ZEN 311
2SA48	NA	NA	GE-51	NA	NA	NA	NA	NA	NA	NA	NA	NA
2SA49	RS276-2003	T-639	GE-51	ICC-639	TR-17	PTC 109	HEP-639	SK 3005	RT-188	ECG 126	WEP 635	ZEN 314
2SA50	RS276-2003	T-632	GE-53	ICC-632	TR-17	PTC 109	HEP-632	SK 3005	RT-123	ECG 102A	WEP 250	ZEN 308
2SA51	RS276-2004	T-250	GE-51	ICC-250	TR-17	PTC 109	HEP-250	SK 3005	RT-183	ECG 160	WEP 637	ZEN 302
2SA52	RS276-2003	T-639	GE-51	ICC-639	TR-17	PTC 109	HEP-639	SK 3003	RT-188	ECG 126	WEP 635	ZEN 314
2SA53	RS276-2003	T-639	GE-51	ICC-639	TR-17	PTC 109	HEP-639	SK 3005	RT-188	ECG 126	WEP 635	ZEN 314
2SA54	RS276-2003	T-3	GE-1	ICC-3	TR-17	PTC 109	HEP-3	SK 3005	RT 183	ECG 160	WEP 637	ZEN 301
2SA55	RS276-2004	T-253	GE-2	ICC-253	TR-05	PTC 102	HEP-253	SK 3005	RT-118	ECG 100	WEP 254	ZEN 304
2SA56	RS276-2003	T-1	GE-1	ICC-1	NA	PTC 109	HEP-G0008	NA	NA	ECG 160	WEP-637	NA
2SA56A	NA	NA	GE-22	NA	NA	NA	HEP-S0019	NA	RT-126	NA	NA	NA
2SA57	NA	T-639	GE-51	ICC-639	TR-17	PTC 107	HEP-G0008	SK 3008	RT-119	ECG 126	WEP-635	ZEN 314
2SA58	RS276-2003	T-639	GE-51	ICC-639	NA	PTC 107	HEP-G0008	SK 3006	RT-188	ECG 126	WEP-635	ZEN 314
2SA58G	NA	T-639	NA	NA	NA	NA	HEP-G0008	NA	RT-183	NA	NA	NA
2SA59	RS276-2003	T-639	GE-51	ICC-639	TR-12	PTC 107	HEP-G0008	SK 3007	RT-183	ECG 126	WEP-635	ZEN 314
2SA60	RS276-2003	T-639	GE-51	ICC-639	TR-05	PTC 107	HEP-G0008	SK 3006	RT-188	ECG 126	WEP-635	ZEN 314
2SA60G	NA	T-639	NA	NA	NA	NA	HEP-G0008	NA	RT-183	NA	NA	NA
2SA61	RS276-2003	T-637	GE-2	ICC-367	TR-17	PTC 102	HEP-G0003	SK 3005	RT-183	ECG 160	WEP-637	NA
2SA64	RS276-2004	T-250	GE-52	ICC-250	IRTR-85	PTC 107	HEP-G0005	SK 3008	RT-121	ECG 102A	WEP-250	ZEN 302
2SA64B	NA	NA	NA	NA	NA	NA	HEP-S0019	NA	RT-126A	NA	NA	NA
2SA65	RS276-2004	T-250	GE-2	ICC-250	IRTR-85	PTC 102	HEP-G0005	SK 3005	RT-121	ECG 102A	WEP-250	ZEN 302
2SA66	RS276-2004	T-250	GE-2	ICC-250	IRTR-85	PTC 102	HEP-G0005	SK 3005	RT-121	ECG 102A	WEP-250	ZEN 302
2SA67	RS276-2004	T-250	GE-2	ICC-250	TR-06	PTC 102	HEP-G0005	SK 3006	RT-188	ECG 126	WEP-635	ZEN 302
2SA69	RS276-2003	T-640	GE-50	ICC-640	TR-17	PTC 107	HEP-G0008	SK 3006	RT-188	ECG 126	WEP-635	ZEN 302
2SA70	RS276-2003	T-640	GE-50	ICC-640	TR-17	PTC 107	HEP-G0008	SK 3006	RT-188	ECG 160	WEP-637	NA
2SA70-08	NA	NA	GE-50	NA	TR-17	PTC 107	NA	SK 3006	RT-188	NA	NA	NA
2SA70F	NA	T-636	GE-50	ICC-633	TR-17	PTC 107	HEP-G0008	SK 3006	RT-188	ECG 160	WEP-637	ZEN 312
2SA70L	RS276-2003	T-637	GE-51	ICC-637	TR-17	NA	HEP-G0003	NA	RT-188	ECG 160	WEP-637	NA
2SA70MA	RS276-2003	T-637	GE-50	ICC-637	TR-17	PTC 107	HEP-G0003	SK 3006	RT-188	ECG 160	WEP-637	NA
2SA70-OB	NA	NA	NA	NA	NA	NA	NA	SK 3006	RT-188	NA	NA	NA
2SA70-8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2SA70Y	NA	NA	GE-50	NA	TR-17	PTC 107	NA	SK 3006	RT-188	NA	NA	NA
2SA71	RS276-2003	T-640	GE-50	ICC-670	TR-17	PTC 107	HEP-G0008	SK 3006	RT-188	ECG 126	WEP-635	NA
2SA71A	NA	T-253	GE-50	ICC-253	TR-17	PTC 107	HEP-G0005	SK 3006	RT-188	ECG 126	WEP-635	ZEN 304
2SA71AB	NA	T-639	GE-50	ICC-639	TR-17	PTC 107	HEP-G0008	SK 3006	RT-188	ECG 126	WEP-635	ZEN 314
2SA71AC	NA	T-640	GE-50	ICC-640	TR-17	PTC 107	HEP-G0008	SK 3006	RT-188	ECG 126	WEP-635	NA
2SA71B	NA	T-635	GE-50	ICC-635	TR-17	PTC 107	HEP-G0001	SK 3006	RT-188	ECG 126	WEP-635	ZEN 311
2SA71BS	NA	T-635	GE-50	ICC-635	TR-17	PTC 107	HEP-G0001	SK 3006	RT-188	ECG 126	WEP-635	ZEN 311
2SA71D	NA	T-635	NA	ICC-635	IRTR-85	NA	HEP-G0001	SK 3006	RT-188	ECG 126	WEP-635	NA
2SA71Y	NA	T-635	GE-50	ICC-635	TR-17	PTC 107	HEP-G0001	SK 3006	RT-188	ECG 126	WEP-635	ZEN 311
2SA72	RS276-2003	T-639	GE-51	NA	TR-17	PTC 107	HEP-G0008	SK 3006	RT-183	ECG 126	WEP-635	ZEN 314
2SA72 BLU	RS276-2003	T-640	NA	ICC-640	IRTR-85	NA	HEP-G0008	SK 3006	RT-183	ECG 126	WEP-635	NA
2SA72 BLU-BLU	RS276-2003	T-640	NA	ICC-640	IRTR-85	NA	HEP-G0008	SK 3006	RT-183	ECG 126	WEP-635	NA

NA=NOT AVAILABLE

(continued next month)

R-E's Service Clinic

Scan-derived DC power supplies

They're easy to service if you know how they work

by JACK DARR
SERVICE EDITOR

SEVERAL OF THE LATER MODEL SOLID-state color-TV chassis have come up with an interesting feature. This is called by quite a few different names (one even calls it an "electronic power supply!"). Probably the most descriptive term is Admiral's "scan-derived power supply." It's really simple; all it means is that some or all of the operating DC voltage supplies do not come directly from the AC line through a rectifier, but originate in the horizontal output transformer. One little Sony portable supplies the picture tube heater from a winding on the horizontal driver transformer!

There is a good reason for this. Since the operating frequency is so much higher, the transformer can be made much smaller. Filtering is also simplified. You can use a much smaller capacitor at 15.75 kHz than you need at 60 Hz. Since the voltages needed for solid-state circuits are lower, it's not nearly as hard as it sounds.

The actual power used does come from the AC line, of course. This can be as simple as a half-wave rectifier often fed directly from the AC line, sometimes from a power transformer. Here, the power transformer could be a simple 1 : 1 isolation transformer. This DC supply feeds the horizontal oscillator and output stage. Extra windings on the flyback transformer provide the operating voltages for the rest of the set.

In many sets, especially those with remote control and/or Instant-On, the set is never completely turned off. When the switch is turned off, the power supply to the horizontal oscillator and output is not cut off, but reduced. So, a lower DC voltage is present to keep the remote control units working and the picture tube heater warm. The high-voltage and sound circuits are "turned down" to the point where they stop working.

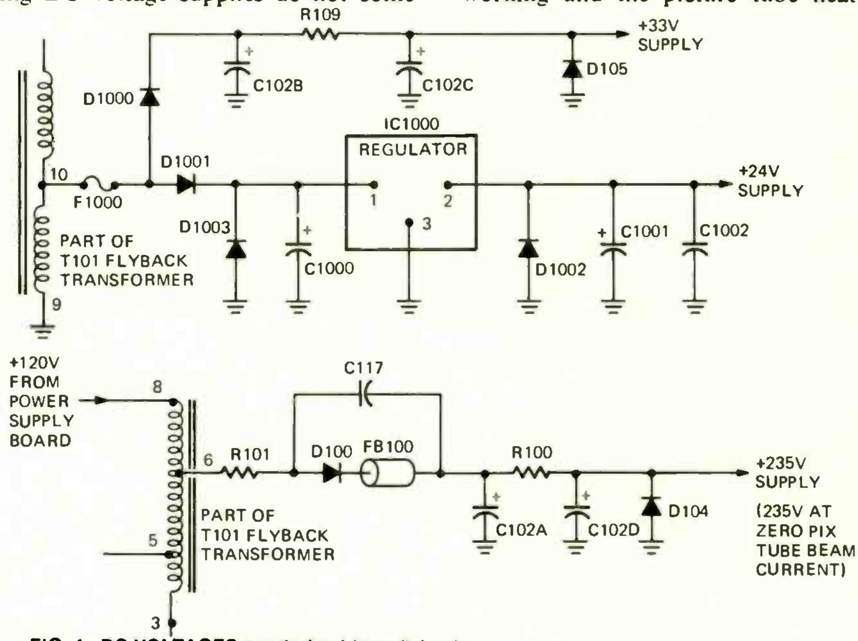


FIG. 1—DC VOLTAGES are derived from flyback.

Admiral's M10 chassis is a good example of this type of circuit. Figure 1 shows the three scan-derived DC power supplies. The +120 volts comes from a regulated DC power supply, fed by the +145 volts DC from the AC line circuit. This +120 volts drives the horizontal oscillator and output stages. At turn-on, this is the only DC voltage present. As soon as the oscillator starts driving the output stage, everything else starts too. In a solid-state circuit, this is almost instantaneous.

The +235 volt supply provides the higher voltages needed for the picture-tube grids and the three video driver stages. The picture tube screen grids are fed from a tap on the focus voltage, which in turn comes from a tap on the voltage tripler used in the high-voltage supply.

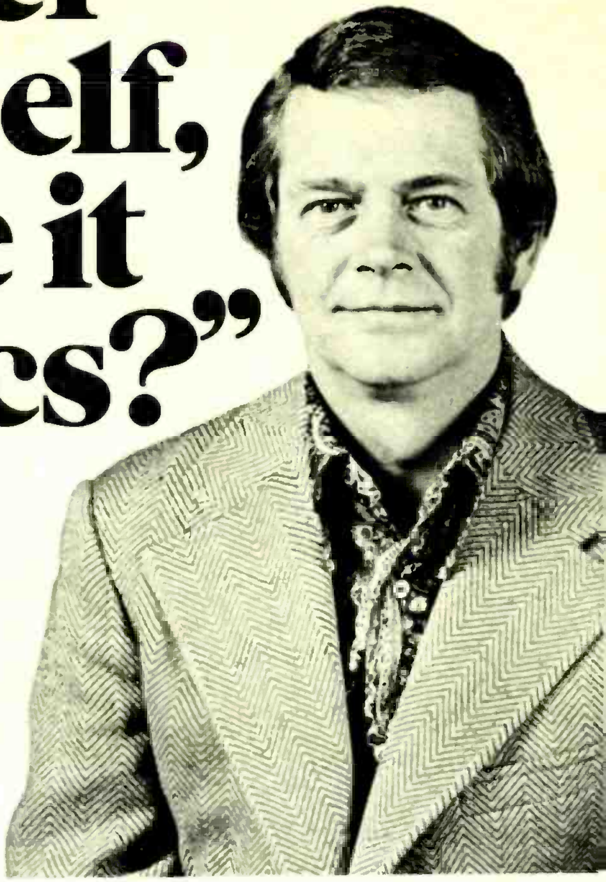
The +33 volt supply is fed by a posi-

(continued on page 68)

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.

Have you ever asked yourself, "Can I make it in Electronics?"



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SERVICE CLINIC

(continued from page 63)

tive-going pulse from the flyback winding. This is rectified, filtered, and protected against negative transients by the shunt diode D105. The same pulse is used to feed D1001 which in turn goes through an IC voltage regulator to get the regulated +24 volt supply. Diodes D1002 and D1003 provide negative-transient protection for this. F1000, a 1.5A fuse, protects both of these supplies. The +120 volt and +235 volt lines as well as the AC input are also fused, back in the power supply.

Figure 2 shows the part of the power-supply circuit. When the set is turned on, there is no scan-derived +235 volt supply at first. The unregulated +145 volt B+ from the AC line and rectifier is applied to the two pass transistors in the regulator. Start-up diode D902 will conduct, applying voltage to the Zener diode D901. This starts the regulator conducting, thus feeding power to the horizontal circuits for the split second needed to get them going. When the scan-derived +235 volts appears, it reverse biases the start-up diode and it has no further function. The +235 volts is divided down by R900 and R909, and clamped by the reference Zener to control the voltage regulator.

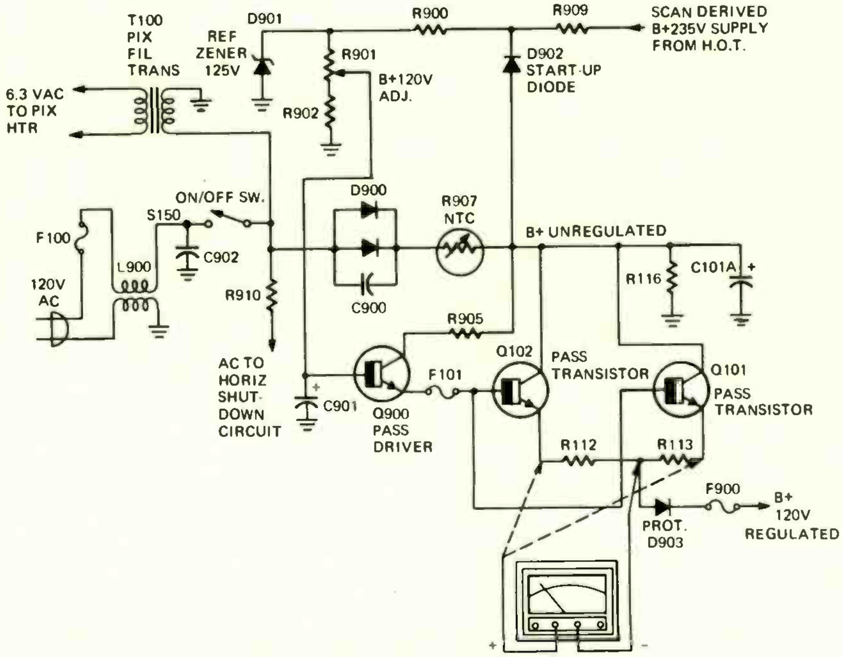


FIG. 2—DC POWER comes from AC line through a regulator.

In this type of circuit, there is no adjustment in the high-voltage supply itself. Regulation is taken care of by controlling the +120 volt supply with the reference diode D901. This voltage is applied to the pass-driver transistor's base through the variable resistor R901. To set up the regulator circuit, you apply exactly 120 volts AC to the set, and adjust the B+120VADJ control until the regulator output voltage is exactly +120 volts. The high-voltage will then be correct, and the other DC voltages as well.

Servicing

This kind of circuit may look like a can of worms, especially on the full schematic. They're not all that hard to service. A few quick checks of key test points will lead you right to the cause of any trouble. To begin with, check the unregulated 145V B+ from the line power supply. This must be there before anything else can happen.

After this, check the output of the +120 volt regulator circuit. To check this stage for the correct regulator action, read the emitter voltages of the two pass transistors. This should be exactly +120 volts. To make sure that both transistors are working properly, carefully put the negative lead of the VOM on the junction of the two emitter resistors, R112/R113. Then read the voltage on each emitter; this will be about +0.5 to +0.6 volt. These voltages must be within 0.1 volt of each other. Too much difference means that one of the pass transistors isn't working too well.

If this checks out, go to the horizontal oscillator stage. Make sure that the oscillator is running. A failure of any of the small transistors in this stage will disable the whole thing. Next, check the horizontal output transistor. The quickest way of checking all of these is to read any one of the three scan-derived DC voltages. If even one of these is normal, the oscillator and output stages are working.

For example, if the +33 volt supply

is all right, but you have no +24 volt supply, the driving pulse must be there. You would have something like a bad rectifier diode, faulty IC regulator, etc. If the 1.5A fuse F1000 is open, this will kill both of the low-voltage supplies. This would point to something like a short in either one, or a short in one of the loads fed from them. These can be checked out in a short time by disconnecting things.

For a complete description of these circuits, see Admiral's Service News Letter, January and March 1975. For the complete schematic, Admiral Service Data S1349. Thanks, Admiral! **R-E**

reader questions

INTERCHANGEABLE TUBES?

This Dumont 41P01 portable looks just like the picture in Sams, on the outside. When I took the back off, I found the enclosed tube layout pasted inside. Sams shows a 5HA7/5HC7 tube, and this one has a 6LX8. A factory man says that it should be one of these two; he has no record of a 6LX8. Sams does show a 6LX8 as an alternate. Who's right here?—H.P., Brooklyn, NY.

Sams is. If your set has a 6LX8, and it is obviously a "factory job", this was a modification at the factory. Incidentally, in this set, you must use the type of tube you found in there! The 5HA7 and 5HC7 are not interchangeable, I'm fairly sure! The tube manual says these are "dual *dissimilar* triodes" and the triodes are reversed between the 12FQ base of the 5HA7 and the 12FR base of the 5HC7. The 6LX8 is a triode-pentode with a 9DC base (9-pin).

NO HIGH VOLTAGE, HOT 6JE6

There is no high voltage in this Emerson 822A and the 6JE6 gets red-hot when the high-voltage lead is connected to the picture tube. Disconnected, this lead checks 25-30 kV. Everything around the high-voltage circuit seems OK. Help would be appreciated.—S.M., Wilmington, DE.

Help is on the way! Take the high-voltage lead off the picture tube and tuck it away somewhere. Now measure all of the DC voltages on the picture tube base, especially the cathode and control grid voltages. From the reaction, your picture tube is biased so much positive on the grids that it's drawing far too much beam current. This can be due to the control grid voltages being too much positive, or to the cathodes being too far negative! You might have an open video peaker, L17, in the cathode circuit. This has happened.

(Feedback from reader; this was it! Replaced by Miller 7600, and it worked. Even a blind pig gets an acorn once in a while!)

SKILL IS ALL RIGHT IN ITS PLACE

I need a power transformer for a Tonecrest radio-stereo. No numbers at all on the chassis, and it's made in Canada. I've looked everywwhere but can't find any information. The owner is bugging me for this; help!—F.Y., Los Angeles, CA.

Check the Sams Photofact Folder 673-6 for a Clairtone C303. The power transformer has exactly the same part number and the tube lineup is the same as the one you sent! Unbelievably, this was in the *second* folder I checked. I crossed the name Tonecrest and got Clairtone and some more, and started looking. Skill is all right in its place, but a little luck beats it any day! Try a Triad R127A or Thordarson 26R112. Should match perfectly.

(continued on page 77)

MATV Splitters

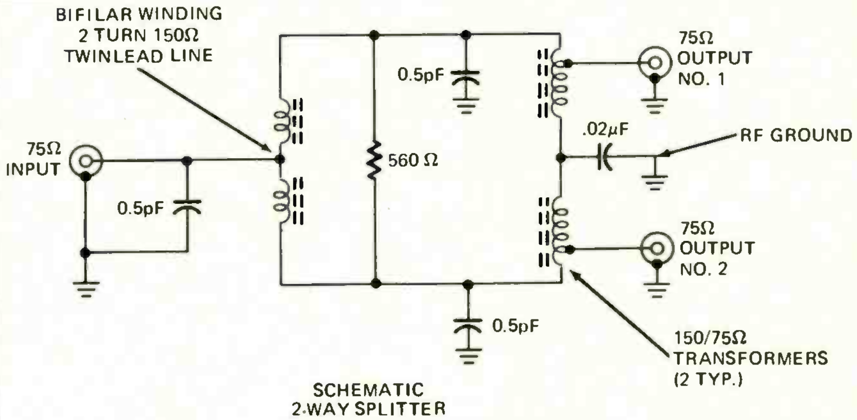
Splitters are relatively simple devices, but they are a potent weapon in the MATV system designers arsenal.

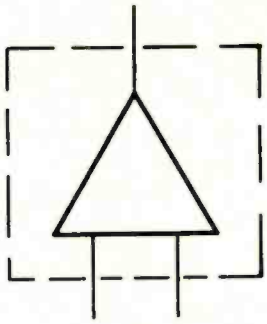
by JAMES E. KLUGE*

SPLITTERS, LIKE THEIR NAME IMPLIES, divide a signal voltage into two or more identical parts. Each part contains all the information that was contained in the original signal before splitting. All that is lost in the splitting process is power level.

Branching feeder lines

Splitters provide a way to branch an MATV system into several routes or feeder lines. Each feeder then services a portion of a building, such as a wing or a floor or a row of mobile homes if in a large mobile-home park.





SIMPLIFIED DIAGRAM and complete schematic of 2-way splitter. Two-way line splitter divides the input signal from a single 75-ohm coaxial line into two separate 75-ohm trunk lines, each containing all information on the input signal.

If a single run or loop of coaxial cable supplied an entire building or mobile-home park, cable loss would become excessive and many line amplifiers would be required to power it. On the other hand, splitters located at a central point could supply several feeder lines branching out toward the extremities of the building or areas. Cable loss, then, would be limited only to the longest feeder line.

Insertion loss

Since a whole equals the sum of its parts, a signal split into two parts has half the power in one part, the other half in the other part. Thus, a signal reduced from full power to half power experiences a 3-dB loss. Likewise, the dual outputs of a 2-way splitter should be 3-dB less than the input signal. Actually, the loss measures 3.5 to 4.0 dB depending on frequency. In addition, to the 3-db splitter loss, high-frequency losses in the splitter components account for another 0.5 to 1.0 dB.

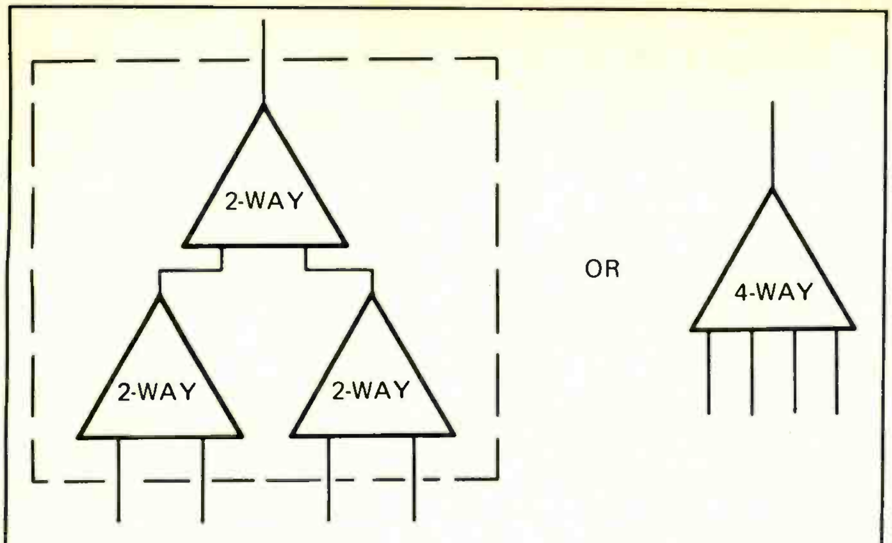
Isolation

Because line splitters employ transformer action, high isolation exists between outputs. The high isolation helps prevent interference, spurious signals and reflections that appear on one output line from getting onto the other output line. Typical isolation value for a good splitter is 18 to 20 dB between outputs.

2-, 4-, and 8-way splitters

Basically, the splitter is a 2-output device. Four-way splitters consist of a

*Technical Editor
Winegard Company

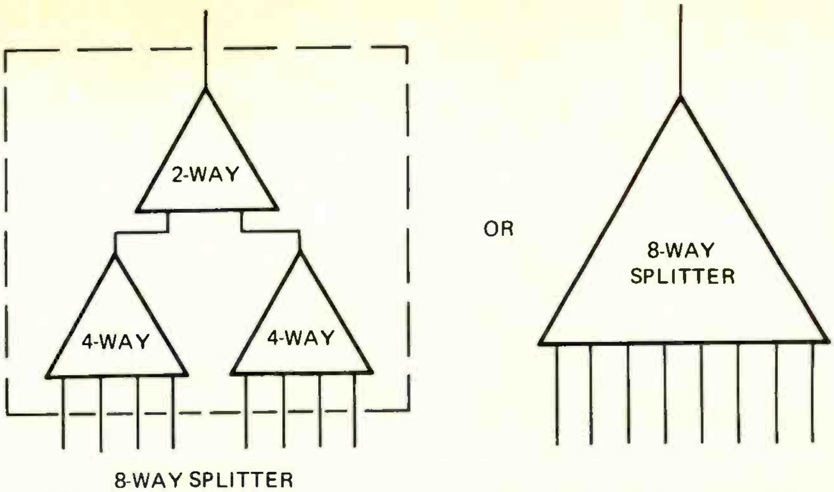


4-WAY SPLITTER

FOUR-WAY LINE SPLITTER divides the input signal into four separate outputs each contain all information on the input signal.

BOOSTER COUPLER CONTAINS broadband amplifier feeding a 4-way line splitter. Power cord goes to 118V, 60 Hz source providing power to amplifier.

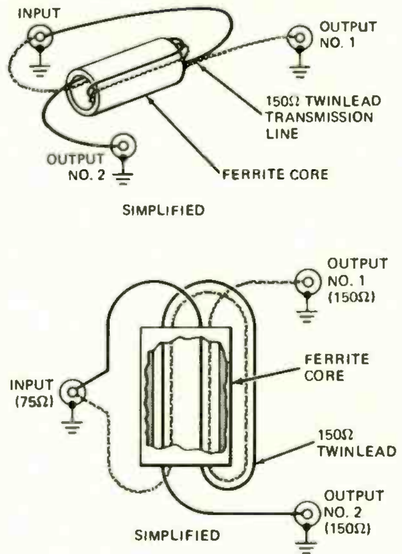
pair of 2-way splitters fed from each of the two outputs of another 2-way splitter. Such an arrangement gives us four outputs from one input. The insertion loss doubles but the isolation



EIGHT-WAY LINE SPLITTER divides the input signal into eight individual signals each containing all information on the input signal.

remains the same. Likewise, an 8-way splitter has two 4-way splitters fed from each of two outputs of a 2-way splitter.

Splitters can also be inverted to combine two signals into one. Applications include combining two antenna down-



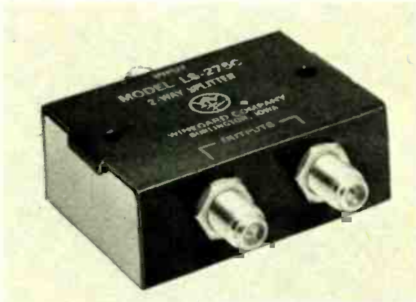
SIMPLIFIED SCHEMATICS of two different inductive two-way splitters are shown in the diagram above.

leads into one or the outputs of two amplifiers into one line.

Splitters are commonly available in 2-way and 4-way versions with 8-way types being less common. However, most any combination can be had by combining 2-way and 4-way splitters in cascade.

Booster couplers

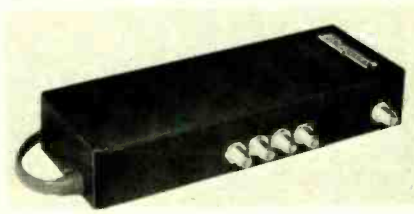
If splitter loss (insertion loss) is a problem, you many want to consider booster couplers. A booster coupler is simply a broadband amplifier followed by a splitter, usually a 4-way. Most booster couplers have a high input capability of the order of +34 dBmV for 7 VHF channels and 5 UHF chan-



WINEGARD MODEL LS-275C two-way splitter.

nels. The gain, usually 6 dB between the input and each output, overcomes the cable and splitter losses to maintain high line levels.

Most splitters and booster couplers are 82-channel VHF/UHF types.



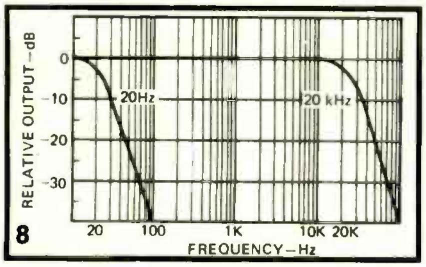
WINEGARD MODEL LS-475C amplified 4-way splitter.

There are VHF-only types also available. Booster couplers require 117V, 60 Hz AC power, restricting their location somewhat while line splitters, being passive can be located anywhere. **R-E**

(continued from page 41)

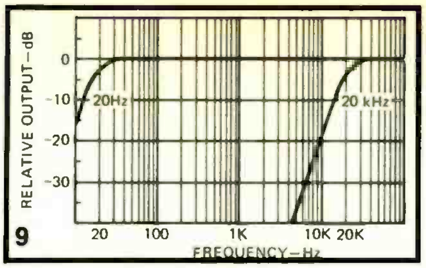
The high-pass output signal from IC3-a is also applied through the crossover-filter switch to the selected RC filter components. Operational amplifiers IC4-a, IC4-b and IC5-a form a three-pole, low-pass 18 dB/octave Butterworth filter. This filter produces the non-inverted low-pass output, while operational amplifier IC5-b creates the low pass inverted output.

Measurements of primary interest in a product of this type are accuracy of filter response characteristics, distortion, and phase response. Figure 8 is a plot of response of the high pass filter section for

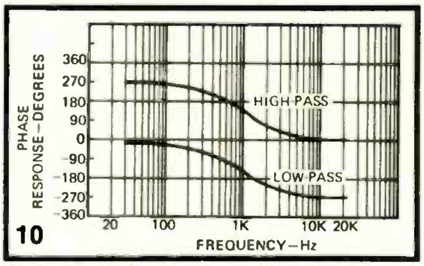


two extreme settings of corner frequencies, namely 20 Hz and 20 kHz. Figure 9 shows the response characteristics of the low-pass filter section when it is set to these same frequencies. Superimposing the plots will show that the −3dB point in both cases corresponds exactly to the 20 Hz or 20 kHz points desired.

IM distortion was measured for each of



the two channels. In both cases we measured less than 0.01% at 9 volts output and this reading (the limit of our test equipment) remained constant down to outputs of as low as 30 millivolts or so, increasing to about 0.02% for lower outputs. Signal to noise ratio for unity gain in each channel measured 107 dB, prob-



ably a good deal better than the S/N ratio of any power amplifier.

Phase response of the low- and high-pass filters, when set for a corner frequency of 1 kHz, is plotted in Fig. 10 and is typical of the phase characteristic that one would expect from a 3-pole Butterworth filter configuration. **R-E**

COLOR TV CAMERA

(continued from page 44)

pear on the monitor screen. Adjustment of the focus control R3, the optical lens focus and the target control R2, should bring the scene into sharp focus with sufficient contrast. Due to the series arrangement of R3 and R2, some interaction will be encountered. The focus control should always be the last one adjusted. In normal operation, only the focus controls will have to be re-adjusted.

Initial adjustments of the deflection assembly

If the camera images appear off-center and cannot be brought into registration with the PM alignment magnet adjustments (see Fig. 4), the yoke windings must be demagnetized. Momentarily, connect the yoke windings across a variable DC voltage power supply set to about 12 volts. Reverse the leads and lower the power supply setting about 1 volt. Keep reversing the windings and momentarily magnetizing the yoke at decreasing 1 volt increments. At below the 1 volt point, the residual magnetism that remains should be within the corrective range of the yoke PM alignment magnets. The objective of this process is to get the magnetism levels at a low enough point so that all registration and centering adjustments for both the yokes can be made by simply rotating the alignment rings. With both camera heads in proper focus optically and electrically, it will be necessary to loosen the yoke hold-down screws, Fig. 4, to allow rotation of the yoke within the focus coil, to correct for vertical axis errors. It should also be remembered that exact positioning of the lens mount will alter the axis of the lens, changing the apparent vertical or horizontal centering in relation to the other channel.

The best construction approach will probably be to simply build each camera head as a black and white unit, thoroughly testing it without using the prism or color filters. When results are satisfactory, initial color registration can be attempted. Insert the color filters behind the lens mount. The edges can simply be taped in place. Be sure to allow the camera to warm up sufficiently before performing registration adjustments. Place the test pattern in front of the prism at the minimum distance at which you want the camera to focus. Adjust both lenses for nearest focus. Slide the cyan vidicon tube back and forth until the sharpest focus is attained. Re-adjust the electrical focus for sharpest image. Then using the adjusted cyan image as a reference, slide the red vidicon back and forth for best focus. Tighten the vidicon tube clamp (see Fig. 4). Adjust red electrical focus for sharpest image. Adjust the red alignment magnets to bring both images in register. It will be necessary to rotate yoke, adjust vertical scan amplitude and perhaps select values for resistor R22 for best registration. It will be necessary to repeat adjustments several times initially. The above adjustments can be made while viewing the picture in either cyan or red. When it is necessary to view a single channel, simply close the iris on the undesired channel.

Final color adjustments

As mentioned last month, the easiest way to adjust color is by adjusting the lens iris controls on a white test pattern with color stripes. Both images together should produce a good white from the test pattern. When the proper levels are set, the other colors should appear in the correct order. The only discrepancy will be with yellow, which may appear as a yellowish-beige. To insure good color fidelity, the red, blue and green controls on the color monitor must be adjusted to produce a perfect gray raster with the camera on and operating, but with both iris controls closed. These adjustments will of course, be critical due to the fact that the tint control has no effect with this particular set up. Due to the high amount of light loss through the prism (each tube receives only 30% of incoming light), a very high amount of illumination will be required for good color fidelity. I use No. 2 photo-flood blubs. If the scene has a slight pinkish cast, or the yellow appears too pink, it is possible the light bulb is too close to the subject. The camera sensitivity could be greatly increased with a higher efficiency prism or perhaps a mirror optic system which would overcome much of the light loss encountered with the present prism.

It is anticipated that some camera builders may be able to locate high efficiency prisms or low light loss semi-silvered mirrors. It is possible by using a more complex mirror arrangement to put both camera heads in line, thereby making a somewhat smaller and more compact camera. Inasmuch that this is the first known home experimenter or amateur type of live color camera, it is recognized that many modifications, changes and improvements could be incorporated by individual camera builders. For example, by using the camera in conjunction with a commercial N.T.S.C. color encoder, some inherent color deficiencies may be correctable.

Next month we will cover construction of the color monitor sync circuits, red and cyan amplifiers, as well as modification of the two TV sets for use with the camera. **R-E**

Ultrasonic measurement system will aid medical researchers

A new ultrasonic measuring system developed recently by RCA will provide medical researchers with previously unavailable precise measurements of ultrasonic diagnostic devices. In so doing, it may increase and speed up the use of ultra-high-frequency sound in detecting malignancies in human tissue.

Ultrasonic techniques have been preferred for many types of research because they enable body tissue features to be observed that can't be seen by X-ray or optical techniques. But up to now, researchers had no way of knowing precisely the intensity of the waves they were using. This created difficulties in determining exactly what effect increasing or decreasing the intensity or frequency of the sonic waves had in detecting malignancies or tissue malformations.

To measure the output of an unltrasonic transmitter with the new technique, it is placed in a water tank containing a gold-plated pellicle 15-cm in diameter and a few millionths of a meter thick. The pellicle, or membrane, is so thin as to be transparent to sound and follows exactly the microscopic motions of the water that make up the sound waves passing through it, vibrating in proportion to the intensity of the sound waves reaching it.

Its motions are sensed by scanning a laser beam across the pellicle horizontally and vertically. The reflected beam is minutely altered (phase-modulated) by the pellicle's vibrations. An interferometer compares the modulated beam with an unmodulated reference laser beam and produces electric signals that can be measured by conventional electric meters.

When the system is used to measure ultrasonic waves passing through tissue, the waves are transmitted through or reflected from the specimen and imaged, or focused, onto the pellicle by plastic acoustic lenses. The pellicle is so tightly coupled to the water that its vibrations at any point are determined by the amount of sound that reaches that point. That amount depends on how much sound was imaged through the specimen. Mapping the small motions of the pellicle with the laser interferometer technique provides an image of the specimen on the cathode-ray display tube.

With a 15-milliwatt laser, the system has a potential sensitivity of about 5 nanowatts-per-square-centimeter, corresponding to a membrane displacent of .007 angstroms at 1.5 MHz. The system has a wide frequency response—about 0.5 MHz to approximately 10 MHz. **R-E**

STEP-BY-STEP
(continued from page 60)

the receiver again plugged into a line isolation transformer, the waveforms swing out tall and steady. Top trace in Fig. 4, now has more than 20 volts AC swing with a DC level in excess of 40 volts, and with the color control only half open. This waveform should swing to 40 volts with the color control turned fully clockwise—and it does. As a backup, and without using double photo exposure, the B-Y output of this set is also shown in the lower trace of Fig. 4 at 50 volts/division. Therefore, it is riding at a DC level of just over 150 volts, the 3rd and 9th bars are at zero reference, and the overall waveform, including the 10-μs blanking pulses amounts to a total amplitude of 120 volts.

Now, with the tuner set on channel 3—which accomodates most color bar generators—the vector pattern turns out as shown in Fig. 5. Naturally I did a little fine tuning immediately after transistor replacement, and touched up the two bandpass transformers and chroma input coil L501 for best waveform symmetry, no petal crossovers, and put the R-Y third bar at about 90 degrees. You may enlarge this pattern, of course, by merely adjusting your oscilloscope's vertical amplifiers—if you have a modern scope. The smaller display, however, looks cleaner, and makes a somewhat better photograph than does a more spread out pattern. In vector-aligning chroma stages, you *always* start with the chroma takeoff coil, get your narrow petal width, then continue with the first and second bandpass transformers, in that order. Usually, the entire pattern is shaped by these three circuits, with burst and the 3.58 MHz coils having to operate on tint phase settings and R-Y, B-Y demodulator references that select color injection into the various segments of the combined luminance-chroma picture. Consequently, since this is an RBG-Y color difference set where luminance goes to the cathodes of the picture tube and chroma to its grids, the color-video mix takes place in the tube itself.

Color faults aren't that tough

Color problems aren't really all that difficult, if you'll remember there are three basic signal paths that must be operated on in the chroma sections. These signal paths are as follows:

1. The 3.08-4.08 MHz, 1 MHz color bandwidth information.
2. Burst amplifier enabling pulses from either the sync separator (Japanese sets) or from the flyback (U.S. sets).
3. Burst, itself, that normally enters the first bandpass amplifier (along with color), is amplified and *then* put to the burst amplifier for color sync processing.

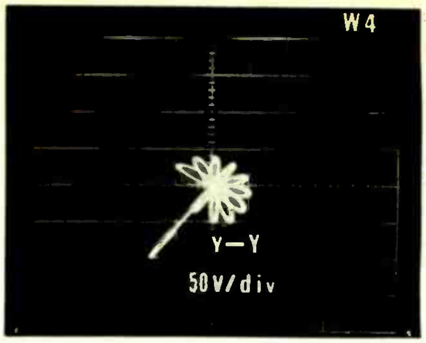


FIG. 5—NORMAL VECTOR PATTERN is shown aligned and with full amplitude.

If all three inputs are identified and followed through their respective stages of amplification and demodulation, there is no way you can miss finding a chroma problem. But digging with an aged VOM or VTVM, especially in solid state circuits, won't resurrect the dead. You'll find it takes an oscilloscope—and a very good one—every time. In chroma circuits, your AC amplitudes—let's forget the term peak-to-peak, it's confusing—and your DC levels should be investigated simultaneously for competent signal analysis. And a good vectorscope will tell all. The final waveform, Fig. 5, now has scope amplifiers set at 50 volts/div., for R-Y, B-Y picture tube inputs, where they should be for most *all* color receivers. If you have to drop to 20 volts, as we did in Fig. 2, somebody's in trouble . . . Let's hope it isn't you. But even troubles like this are simple if logical troubleshooting procedures are followed. **R-E**

READER QUESTIONS

(continued from page 69)

TRANSISTOR REPLACEMENT?

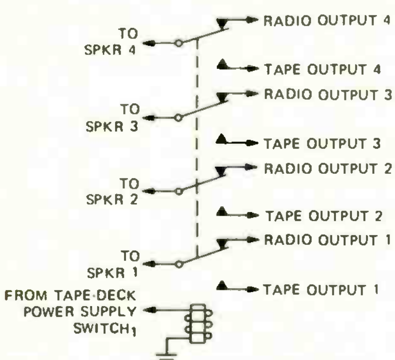
I need a horizontal output transistor for a Westinghouse V-2483-1 chassis. The part number is 29V069C01, and it isn't listed. No one seems to know what to use in here. Can you help?—W.M., Pittsburgh, PA.

You're right; this one isn't listed in any of my seven transistor guides either. However, from the schematic and the ratings, something like an RCA SK-3111 ought to do, or a Motorola HEP-S7005. Both of these seem to have ample safety factors. For the best way, use a variable-voltage line transformer when you turn it on the first time, with current meters, etc. Saves a lot of trouble!

A ROLLS-ROYCE RADIO RELAY?

I want a relay circuit, like the one used in Rolls-Royce cars, that will switch the speakers from radio to tape automatically when the tape deck is turned on. Do you know where I could get this?—L.G., Astoria, NY.

You'll need a 12-volt DC, 4PDT relay. Hook it up as shown. The relay connects the four speakers to the radio



when it is not energized. Connect the relay coil lead to the tape-deck motor connection so that when the tape-deck is turned on, it energizes the relay.

WHERE'S THE OTHER TRANSISTOR?

I can't find the other transistor in the horizontal output stage of this little GE TA chassis. It shows it on the print I have, but I can't find it in the schematic! What's going on?—A.B., Key West, FL.

You have the horizontal output transistor in there. There are no more *transistors* in this circuit. You're being caught by one that's got a lot of people. What you're looking for is the *damper diode*! In this set, this is a GE Part ET57X34, and it is in a TO-3 transistor case! It is mounted right alongside the horizontal output transistor, on the heat-sink.

NO HIGH VOLTAGE

If I take the plate-cap off the horizontal output tube in this Zenith 19CC19, all voltages are normal except the high voltage, of course. If I put this cap back on, everything goes to pieces. It squeals, the high voltage starts to build up and the 26LX6 gets red hot. Horizontal frequency goes away off. Can't get any help from anyone else; how about you?—P.K., Cherry Hill, NJ.

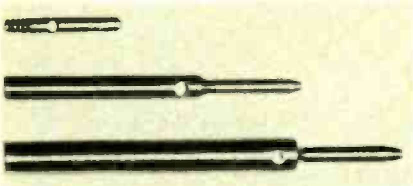
We'll sure give it a good try! This sounds familiar. These are exactly the kind of symptoms you get when you have a filter capacitor *open* in the wrong place (meaning the B+ feed to the horizontal oscillator/output stages. This allows a *feedback* to be set up. This can cancel out the horizontal oscillator, cause a loss of drive and all of the other goodies you see.

Easy check; just scope *all* of the DC voltage supply lines. You should see nothing at all on them, except a nice straight line. Any horizontal-frequency pulses mean trouble. Replace capacitors. **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.

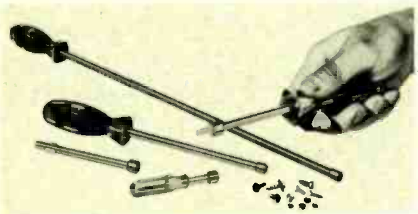
SOLDERING IRON TIPS. Vented Tunnel Tips solder and desolder, all with the same tip. New design optimizes capillary action to enable both functions alternately and continuously. Only the use of "flux" is essential to maintain capillary action. The unique design



permits the tip to surround the connection to both solder and desolder. Tips range in price from $1.98 each to $2.28 each and are available for American Beauty, Ungar, Hunter, Esico, Kwickie, Wall-Lenk and Weller soldering irons.—**Joe Nicosia, c/o Gunmaster,** Box 743, Kings Park, NY 11754.

Circle 31 on reader service card

MAGNETIC NUTDRIVERS. With fixed handles are available in four styles, each in two sizes. The line also includes two sizes of interchangeable shanks which fit in all Series-99 handles, both regular and ratchet types. The permanent Alnico magnet in the



insulated socket holds fasteners firmly for easy, one-hand driving. Styles range from a 3½ in. midget pocket clip to a super long 20¾ in. driver, all in ¼ and 5/16 in. hex openings. Intermediate lengths are 7 and 10 in. Handles are color-coded red or amber. **—Xcelite**, Apex, NC 27502.

Circle 32 on reader service card

3½ DIGIT DVM, *model DVM32*. Portable unit is powered by standard "C" cells, rechargeable, or optional 115/230V line-cord power-adaptor. "Auto-off" circuit turns the LED display off between measurements on any range, when in the AUTO position. A continuous display is available in the normal ON position. The unit has a basic 0.5% DC volts accuracy with 1 mV resolution backed by a 15-megohm input impedance. A 200K isolation resistor in the probe further reduces potential loading error. DVM Lo Power ohms mode uses. .08V test voltage that will not trigger semiconductor junctions during resistance measurements. Accessory high-voltage probe will extend the 2000V range to 40kV for complete measuring capabilities.

Specifications: **DC VOLTS:** 4 Ranges; 0 to 1.999, 19.99, 199.9, 1999. **AC VOLTS:** 4 Ranges; 0 to 1.999, 19.99, 199.9, 1000 volts RMS. Accuracy: 1.5% at 60 Hz from ¼ scale to full scale, 3% from 1/10 to ¼ scale plus or minus 1 dB from 40 Hz to 3 KHz. Input Impedance: 1.8 megohms shunted by 18pF. **OHMS:** Low Power: 5 Ranges; 0 to 199.9 ohms, 1.999K, 19.99K, 199.9K, 1.999 meg-

ohms. Accuracy: 1%. Maximum Test Voltage: 80 millivolts. **OHMS:** High Power: 5 Ranges; 0 to 1.999K, 19.99K, 199.9K, 1.999 megohms, 19.99 megohms. Accuracy: 1% on all ranges except 5% on 19.99 megohms. Maximum Test Voltage: 800 millivolts. **DC CURRENT:** 4 Ranges; 0 to 1.999, 19.99, 199.9, 1999 milliamps. Accuracy: 1%. **AC CURRENT:** 4 Ranges; 0 to 1.999, 19.99, 199.9, 1999 milliamps. Accuracy: Same as AC volts.

Unit weighs 2¼ lbs., measures 7 in. wide × 5 in. high × 4 in. deep. Complete with direct-input probe. The price is $198.00.—**Sencore,** 3200 Sencore Drive, Sioux Falls, SD 57107.

Circle 33 on reader service card

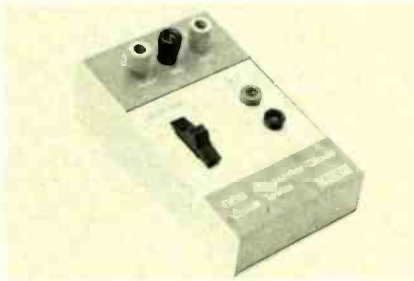
DIGITAL MULTIMETER KIT, *model IM-2202*. 3½ digit display features automatic polarity indication and decimal point placement. Continuous rotation range switch and four pushbutton function switches select any of the ranges. Portable unit is powered by four rechargeable nickel-cadmium batteries and

a built-in charging circuit for up to eight hours of continuous operation. The unit can also be operated from 110 or 220 VAC. 26 ranges include full scale ranges of 100 mV to 1000 volts DC, 100 mV to 750 volts AC, 100 μA to 1000 mA and 100 ohms to 1000K ohms. 100% overrange capability allows measurements up to 1.999 on all ranges except 1000 VDC and 750 VAC, giving full 2A or 2 megohm capability. Overrange is automatically indicated by a flashing "I" display.

If Lab standard is used for calibration, DC accuracy is ±0.2%. For AC, accuracy with a lab standard is ±0.5% to 10 kHz. Internal standards supplied with the kit allow easy field calibration to ±0.5% for DC and ±1% for AC. **Heath Company,** Benton Harbor, MI 49022.

Circle 100 on reader service card

TRANSISTOR CHECKER, *model 688*. Test semiconductors in or out of circuit. Use this unit with your oscilloscope and touch the semiconductor with the probe. The waveform tells its condition at a glance. Switch



selection for "in" or "out" of circuit testing. Checks all diodes and transistors (except MOS FETS). 5-Way binding posts for interconnection to the scope. Prices: $14.95 kit, $22.95 assembled.—**Eico Electronics,** 283 Malta Street, Brooklyn, NY 11207.

Circle 34 on reader service card

TEST JIG CABLE AND ADAPTER KITS. Six new models, one each for servicing RCA, Admiral, Magnavox, Philco, Sylvania and Zenith color-TV. Use with RCA color test jig. Each adaptor packed in plastic case that's

stackable. Shoe box size cases have sliding drawer to make handy storage assembly when no longer needed for the storage of the test jig kit.—**RCA Distributor and Special Products Div.,** P.O. Box 100, Deptford, NJ 08096.

Circle 35 on reader service card

DIGITAL MULTIMETER. *model PM2513*. LSI circuit performs part of the analog circuit functions, the A/D conversion and the digital signal evaluation, reducing the total number of circuit components. A 3½ digit, seven segment LED display with automatic decimal point. Functions selected by push-buttons, ranges with a rotary switch. AC and DC voltages are measured in 5 ranges, from 0.1 to 600V and 0.1 to 1000V, respectively. Resolution is 100 μV in the 0.1V range and accuracy is ±0.2% full-scale ±0.3% of reading for DC and ±0.2% full-scale ±1% of reading for AC. Errors due to the instrument loading are reduced by a 10 megohm input impedance. Five AC and DC current ranges extend from 100 μA to 1A full-scale, with a resolution of 100 μA in the lowest range. Accuracy for both current and resistance measurements is 0.2% full-scale ±1.5% of reading.

Unusual feature is built in provision for temperature measurements which can be

made with an optional probe. Surface temperature measurements cover −50° C to +200° C, with a resolution of 0.1° C and an accuracy of ±1° C.

Unit is powered by 6 standard 1.5V size C batteries. To increase battery life, the circuitry is normally at rest and switched on by means of a special push button for 25 seconds each time a measurement is taken. Optional rechargeable battery pack or normal line voltage is available. Unit measures 7.3 in. high × 6 in. wide × 2.6 in. deep and weighs 3 pounds including batteries. Price is $245.00. The optional temperature probe, model PM9247 is $75.00, a rechargeable battery pack is $15.00.—**Philips Test & Measuring Instruments, Inc.,** 400 Crossways Park Drive, Woodbury, NY 11797.

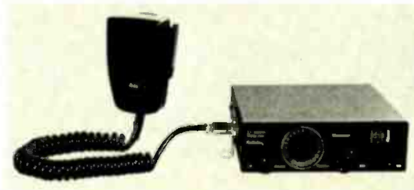
Circle 36 on reader service card

CASSETTE DECK WITH DOLBY. *model CT-F6161.* New cassette deck offers front panel access for cassettes and all operating controls. As a result, the newly designed unit can be mounted in only 5½ inches of shelf height or may be stacked above or below other components. Designed for use with available cassette tapes, the unit presents low distortion and high signal-to-noise ratio and dynamic range. Transport system is

powered by an electronically controlled DC servo motor for high starting torque and is immune to voltage or load fluctuations. Features include built-in selectable Dolby noise reduction for up to 10 dB signal-to-noise improvement. Separate bias and equalization switches for standard, low noise, Chrome and Ferri-Chrome tapes. Illuminated VU level meters plus record mode indicator light. Automatic stop at end of tape travel in play, record and fast wind modes. Three-digit tape counter. Pause control, separate dual mic and line inputs, line outputs and DIN connector. Built-in monitoring amplifier and headphone jack. Specifications include: Frequency response: 30 to 13,000 Hz (40 to 11,000 Hz ±3 dB, standard tape); 30 to 16,000 Hz (40 to 12,000 Hz ±3 dB Chromium Dioxide tape). Signal-to-noise ratio: 58 dB with Dolby on; 48 dB Dolby off (standard tape). Wow and flutter: Less than 0.12% (WRMS). Equalization: Standard or 70 μS (Chrome), selectable. Fast forward or rewind time: Less than 80 seconds (C-60 tape). Input sensitivity: 0.2 mV or 90 mV, Mic; 60 mV to 9 V, Line; 6 mV to 2.7 V DIN. Output level: 300 mV, Line and DIN; 40 mV/8 ohms, Headphone output. Power Requirements: 120V, 60 Hz, 16 watts. Size. 17-13/32 in. W × 5-7/16 in. H × 13 in. D. Price: $299.95.—**U.S. Pioneer Electronics Corp.,** 75 Oxford Drive, Moonachie, NJ 07074.

Circle 37 on reader service card

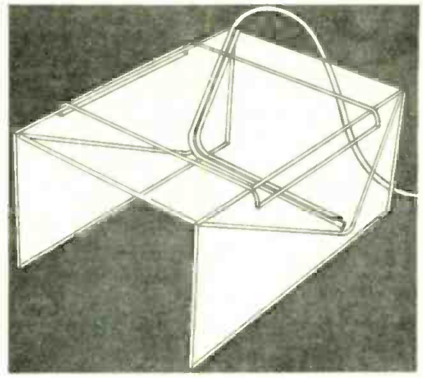
23-CHANNEL CB TRANCEIVER. *model CB 720.* One of two new entries in the CB field features automatic noise limiter, rotary volume on/off control, public address pushbutton control, illuminated signal-radio frequency meter, rotary squelch control, built-in



noise suppression and color-coded channel selector with lighted channel-indicator. Mobile unit will work with either positive or negative ground, has an external speaker jack, a quick mount snap on microphone bracket, and a very convenient antenna connector. Comes complete with all necessary wiring and mounting hardware. **Boman Industries,** 9300 Hall Road, Downey, CA 90241.

Circle 38 on reader service card

BUBBLE ETCHER. Designed to satisfy the printed circuit requirements of small shops. The bubble etcher offers semi-automatic operation and requires only periodic inspection of the board. Vigorous bubbling action provides fast etching while reducing the possibility of staining or undercutting. Unit consists of an etching tray connected to an aquarium air pump that provides bubble agitation of the etchant. The tray and bubble



source are designed to maximize etching rate as determined by the pressure and velocity of the bubbles. The unit is built of ⅛" acrylic which allows etchant temperatures of up to 200°F. The unit measures 11 × 5 × 7¼ inches which permits etching of boards up to 6 × 8 inches. A splash guard protects the surroundings. The unit comes complete and ready to use, except for an easily obtainable aquarium pump. The price is $12.00 excluding pump, $17.50 including pump.—**Trumbull,** 833 Balra Drive, El Cerrito, CA 94530.

Circle 39 on reader service card

CHECK-A-COLOR JIG. *model CK 3000*, is factory tested, fully assembled and ready to use. It can be used on the bench with 48 separate brand name TV sets with anode voltages up to 30,000 volts, and permits fast efficient servicing of 7,000 different solid-state, tube and hybrid color-television chassis. The jig can handle 70° and 90° tubes,

hybrid, transistor and SCR circuitry with a wide range of impedances. A built-in alternate focus supply also permits testing of focus voltages as low as 4.5 kV. A complete set of programmers for the patented yoke circuit is furnished for correct matching to six different receiver deflection outputs. The unit contains a 90° slotted-mask, in-line color picture tube with 13 inches of viewable area and leaded strontium X-ray inhibiting glass. The self contained unit is portable, weighing less than 25 pounds, making it easy to move from one bench to another. Available as optional accessories are adapter kits for the seven most popular TV brands and discrete adapters for 41 more. **GTE Sylvania,** 70 Empire Drive, West Seneca, NY 14224.

Circle 40 on reader service card

CASSETTE EDIT/REPAIR KIT. Permits recordists to repair a broken cassette tape, yet avoid the almost impossible problems associated with disassembling sealed or screw-held shells. Repairs can be made without disturbing the casette components. The handy kit can repair most tape breaks. How-

ever, it cannot fix mishaps in which the tape has pulled free from the hub or broken within six inches of a hub. The kit doubles as a precision editing block. One side has a diagonal cutting guide for normal splicing and a butt cutting guide for close editing. A five-inch channel groove holds the tape. Six adhesive-tipped polyester picks for retreiving tape ends lost inside the cassette housing and six pieces of 150-mil splicing tape, pre-cut to proper length are contained inside the kit along with a fully illustrated instruction booklet. Price: $3.10.—**ERK,** Dept. MA, Box 33600, St. Paul, MN 55133.

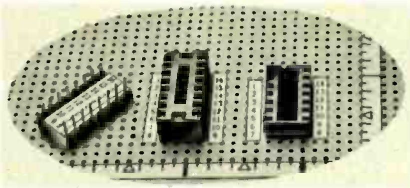
Circle 41 on reader service card

CURVE TRACER, *model IT-1121*. Accurately displays operating parameters of virtually all types of semiconductors including bipolar transistors, diodes, SCR's triacs, FET's, etc. Intended for use by TV service technicians, hobbyists and anyone else who works with

electronic circuits. A semiconductor curve tracer is a valuable aid in selecting devices for specific applications or for sorting, inspecting and testing. It's particularly useful in identifying unknown semiconductors. Price: $89.95 as a kit.—**Heath Company,** Benton Harbor, MI 49022.

Circle 100 on reader service card

PRESS ON LABELS identify DIP socket pins and circuit board hole locations quickly and easily. The 14-pin DIP markers, models MS-9, have double sequential number lines from 1 to 7 on one side and from 8 to 14 on the adjacent side. They're all printed on 0.1-in. centers to match the lead spacing of conventional DIP components. Similar strips are



available for 16-pin DIP's (MS-10) and pairs of single line strips, numbered 1 to 7 and 8 to 14 for 14-pin DIP's (MS-9A), as well as 1 to 8 and 9 to 16 for 16-pin DIP's (MS-10A). All strips are adhesive-backed and self adhering. They come on backing cards. Prices vary from $1.98 for the MS-9 and MS-10 for a package of 36, to $2.45 for the MS-9A and MS-10A for a package of 36.—**Vector Electronic Co., Inc.,** 12460 Gladstone Avenue, Sylmar, CA 91342.

Circle 47 on reader service card

BATTERY CHARGER, *model GP-1044*. A 15A automatic battery charger that can deliver dead battery starts within one minute. A practical solution to dead battery problems in cars, boats and campers using 12-volt lead-acid batteries of automobile size or larger. Unit is completely automatic in the

normal mode, bringing the battery to full charge then automatically shutting down, turning on again only to compensate for normal battery leakage. Pressing a spring loaded switch for not more than one minute gives a 50A boost-surge that puts enough energy into a dead battery to start an

(continued on page 86)

Circle 67 on reader service card

Circle 68 on reader service card

The better the training the better you'll

Send for FREE illustrated career guide

(Simulated TV Reception)

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

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

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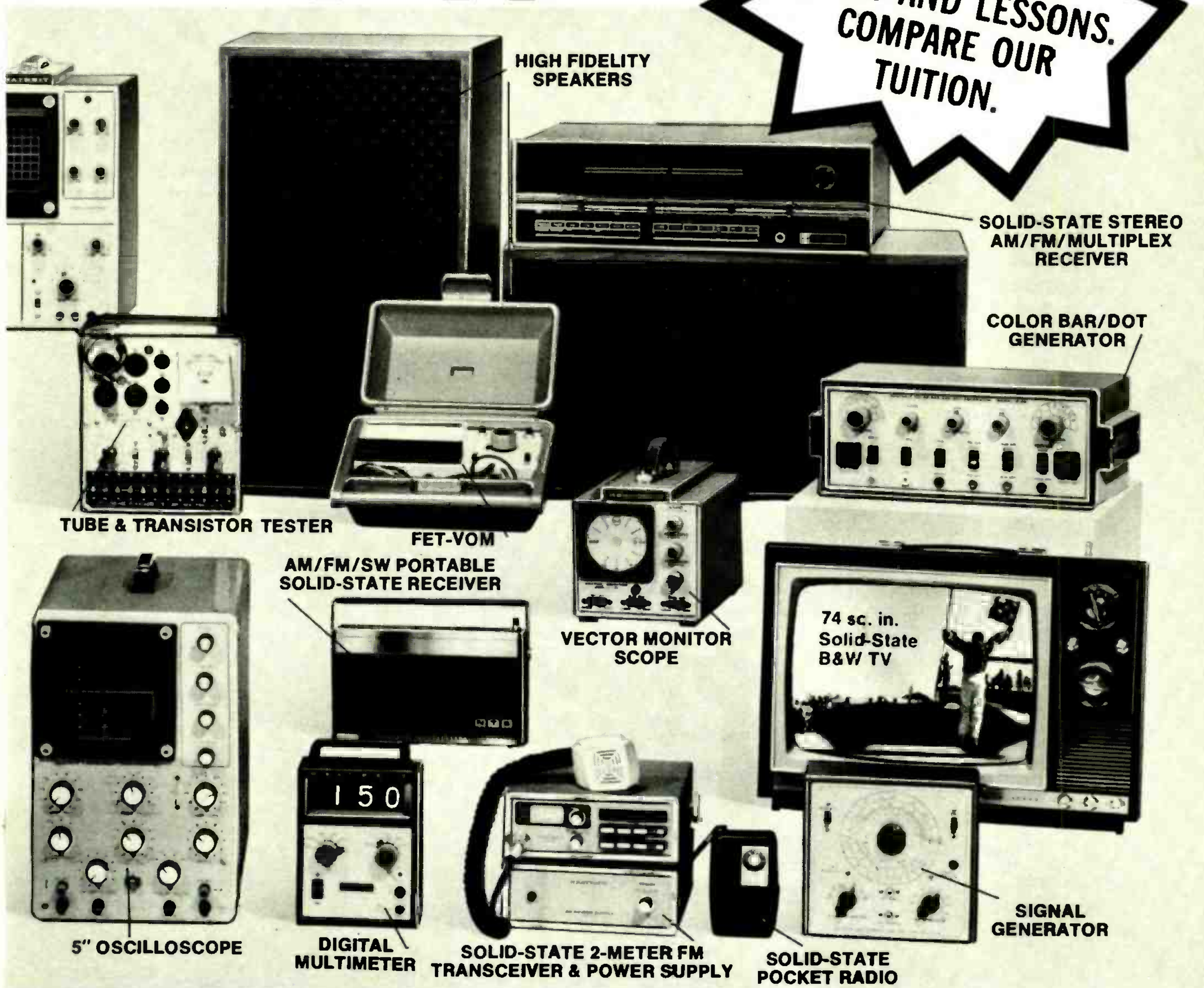

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NEW PRODUCTS
(continued from page 81)

operable engine. A thermo-sensing automatic-resetting circuit breaker protects against over-charging in the boost mode. Price: $49.95 as a kit.—**Heath Company,** Benton Harbor, MI 49022.

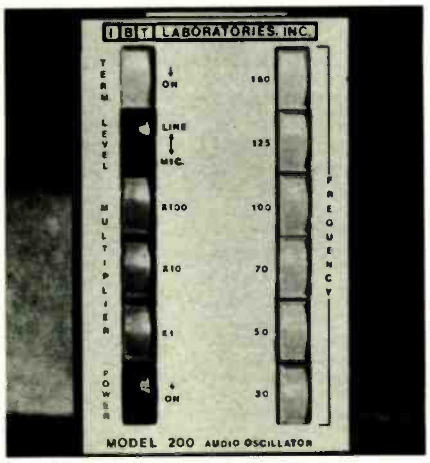
Circle 100 on reader service card

SOLDERING IRONS. Featherweight units have heat-resistant or shielded pencil-like handles and extra long cords. Weight varies from 1¾ oz. to less than 1 lb, even in the

heavy-duty models. Pre-tinned tips of plated copper are replaceable and range from 25 to 175 watts. Price is from $5.50 to $14.00. **Weller, The Cooper Group,** Apex, NC 27502.

Circle 48 on reader service card

OSCILLATOR, *model 200.* Battery-powered audio (sinewave) test oscillator is housed in extruded aluminum case and features 21 pushbutton selectable frequencies that range from 30 Hz to 20 kHz. Output levels of 0 dBm or —50 dBm are available by



pushbutton selection with level tracking of ±0.5 dB over entire frequency range. Output is transformer isolated, balanced, floating and presents an impedance of 600 ohms at the high level setting and 150 ohms at the low level setting. 2^{11}/$_{16}$×4^{1}/$_{16}$× 3^{5}/$_{16}$ in.; $129.95.—**IBT Laboratories, Inc.,** 5200 Myer Court, Rockville, MD 20853.

Circle 49 on reader service card

ELECTRONIC WATCHDOG. Provide insurance for yourself when out of town. If the door of your hotel or motel is opened, a piercing alarm will sound. If the intruder tries to deactivate the unit by standing it upright again or by pushing the only button visible, the unit will not shut off. You are the only one who knows the secret of deactivation. 100% solid-state circuit; electronic oscillator (2900 Hz) produces over 80 dB audio alarm; battery powered with

two 9-volt transistor batteries; 2 × 9 in.; less than 8 oz.; $30.00.—**Harris Electronics,** 271 Mimosa Way, Portola Valley, CA 94025.

Circle 50 on reader service card

SCOPES
(continued from page 59)

X-Y phase measurements

Within the frequency limitations of the horizontal and vertical amplifiers, the X-Y oscilloscope can be used to make phase measurements. The phase measurement technique is similar to the Lissajous frequency measurement. To measure phase, horizontal and vertical amplitude measurements are taken, from which phase angle is computed. For phase measurements. horizontal and vertical display amplitudes must be identical and horizontal and vertical frequencies the same. Independently adjusting each channel, using the variable attenuator, to set the display amplitude at an equal number of divisions is a simple method of assuring identical amplitudes. Figure 22 shows the various 45° phase relationships.

As shown in Figure 23, the exact phase

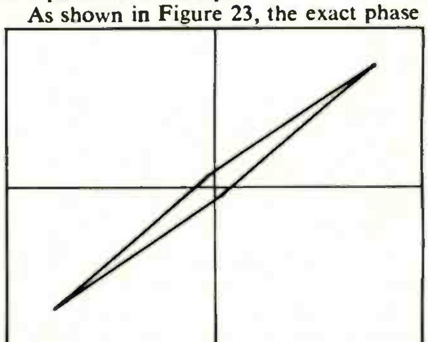


FIG. 24—A 1° PHASE SHIFT measured on **an X-Y oscilloscope.**

relationship may be calculated. Phase measurements made on an X-Y oscilloscope must include any phase difference between the X and Y channels of the oscilloscope at the measurement frequency. For comparison purposes, Figure 24 shows a 1° phase-shift.

(continued next month)

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.

FM TWO-WAY RADIO correspondence course is described in this 8-page pamphlet. The booklet outlines the contents of 40 lessons and 13 reference texts are included with the course offered by Motorola Training Institute. The course covers FM two-way radio from the service technicians point of view.—**MTI**, College Hill Rd., Summerdale, PA 17093.

Circle 42 on reader service card

MICROPHONE SELECTION AND APPLICATION GUIDE. *The Music-Maker's Manual of Microphone Mastery* presents tips from leading sound engineers on how to select and use microphones plus guidelines for on-stage miking situations. The brochure describes in non-technical terms how to professionally mike voices and instruments with listings of soundman-proved techniques for handling especially troublesome sound pickup situations. Also featured are recommended microphones for specific instrumental and vocal styles, microphone positioning hints and a description of a variety of accessories that professional entertainers find helpful—**Shure Brothers Inc.**, 222 Hartrey Avenue, Evanston, IL 60204.

Circle 43 on reader service card

RECORD CARE BOOK. *Just For The Record.* A 28-page book that deals with topics such as the problems of dust and static, how to handle records properly, playing records with changers and automatic turntables, rejuvenating old records, the treatment of 4-channel records, and many other areas that will prove invaluable to anyone who collects and plays records. In addition to offering specific tips on record cleaning, storage and maintenance, the book presents data on stylus and turntable platter care. It also explains the effects of record cleanliness on tracking force. Methods of static elimination are also described.—**Elpa Marketing Industries, Inc.**, New Hyde Park, NY 11040.

Circle 44 on reader service card

A REVOLUTION IN IGNITION SYSTEMS. A 24-page booklet that traces the history of conventional ignition systems describes component functions and details the relatively recent move to electronics. The balance of the book describes the manufacturer's Tiger capacitive discharge ignition system and presents comparative data on transistor and conventional ignition systems.—**Tri-Star Corp.**, P.O. Box 1727, Grand Junction, CO 81501.

Circle 45 on reader service card

BREADBOARDING DEVICES is the subject of this 14-page colorful brochure. The full line of this manufacturer's breadboarding products range from a $5 Proto-clip for power-on-hands-off signal tracing through a logic monitor and on to a variety of breadboarding assemblies. All should be of interest to both the experimenter and industrial technician.—**Continental Specialties Corp.**, 44 Kendall St., New Haven, CT 06512.

Circle 46 on reader service card

books

MODEL SAIL & POWER BOATING . . . BY REMOTE CONTROL, by George Siposs. TAB Books, Blue Ridge Summit, PA 17214. 192 pp. 8½ x 5¼ in. Hardcover $7.95; Softcover $4.95.

This handbook covers all types of model boating—sail and powered, electric and internal-combustion engines. There is no attempt to teach the reader how to assemble one particular type of boat model and it doesn't advocate one specific method of construction. Instead, the author considers all modern techniques and includes enough theory to insure that the reader will understand the basic principles behind the operations of various models and systems. The principles of radio control and radio-control signals are explained in non-technical language. The basics of a control system are enumerated and techniques such as installation, isolating trouble and repairing water damage are covered too. Sail boats, electric-powered boats and internal-combustion engine-powered boats are all covered. To help the beginning hobbyist, there is a chapter on the workshop including recommendations for tools and other useful gadgets.

ELECTRONIC MUSIC PRODUCTION, by Alan Douglas, TAB Books, Blue Ridge Summit, PA 17214. 148 pp. 8½ x 5¼ in. Hardcover $7.95; Softcover $3.95.

Although relatively in its infancy, electronic music has already had considerable influence on musicians and composers in all fields. In this book, the tremendous potential of electronic music is described in its freedom from the limitations of conventional instruments and notation. The author suggests rather than displacing human performers, electronic music will provide the basis of a completely new art form in its own right with its own language, performers and devotees. The book deals first with the properties of conventional music, going on to show how their limitations may be overcome by electronic means. The three principal methods of synthesizing music electronically are described with examples of the latest equipment.

AUTO STEREO SERVICE & INSTALLATION, by Paul L. Dorweiler & Harry E. Hansen. TAB Books, Blue Ridge Summit, PA 17214. 252 pp. 8½ x 5¼ in. Hardcover $8.95; Softcover $5.95.

For the service technician eyeing the growing field of auto stereo system installation and service, this is an extremely useful book. It covers every phase of installation including mounting and adjustment of FM stereo receivers and tape players and it tells how to get rid of troublesome interference caused by the automotive environment. Also included are 48 complete schematics representing 13 major manufacturers plus many other servicing diagrams and sketches. The largest part of the book is devoted to servicing. The subject of general maintenance covers the mechanical aspects which consume much of the technician's time—dial cord and lamp replacement (illustrated, of course), replacing controls, cleaning and adjusting tape players, demagnetizing and tape splicing. **R-E**

(continued from page 51)

SCR circuit placed in a full-wave bridge D9 through D12 (See "Hi-Torque Circuit" section of Fig. 1). The SCR is fired during the starting interval, applying full voltage to the appropriate motor. As capacitor C11 charges, transistors Q3 and Q4 reduce the triggering rate of Q5 which fires the SCR. This reduces the SCR's duty cycle until ultimately, Q5 ceases to trigger the SCR completely as the collector current of Q4 becomes zero. The voltage waveforms at the output of the SCR go through the progression shown in Fig. 5 in from three to five seconds, but the final waveform is sinusoidal which results in smooth motor operation.

Electrical braking

When attempting to bring the reels to a stop, a differential braking action must be used. This means that the reel which is feeding out tape should have greater braking action applied to it than the reel which is taking up the tape. Figures 6 and 7 show two typical conditions requiring differential braking. In Fig 7, a heavily loaded tape feed reel would tend to continue its rotation if stopped in FAST FORWARD, while the takeup reel, having little momentum, would stop almost immediately. This would cause tape spill. Conversely, in Fig. 8, a heavily loaded takeup reel would tend to continue rotating longer than the lightly loaded feed reel and this might stretch or even tear the tape. Some manufacturers have solved the problem by eliminating braking completely from the takeup reel. However, this creates a great deal of tension on the tape unless very soft braking is applied and reel size is limited to 7".

Obviously, in a differential braking system such as the one in the Crown 800 transport, more braking must be applied to the tape feed reel than to the takeup reel, but this differential must have specific limits. It must be great enough to prevent a loop from forming under the conditions shown in Fig. 5 but not so great that the tape can stretch or tear under the conditions shown in Fig. 8. Furthermore, because fast winding must take place in both directions, the function of tape-feed and takeup reels must be reversible. In Fig. 8-a, tape is travelling from left to right and the left reel should have the higher braking force. In Fig. 8-b, tape is running from right to left and the right reel is now the tape feed reel and should have the higher braking force.

The electrical braking system of the transport operates by feeding direct current through the reel motors (DC "freezes" these motors while AC makes them turn). DC is provided for the motors in both the STOP and STANDBY modes, but the "stop" current is higher. This is done by shorting a series resistor. The required differential action is provided by placing a lesser voltage on the takeup motor than on the tape-feed motor.

Since the stopping torque of such a motor with DC applied is proportional to its rate of rotation, stopping tension due to the differential DC voltage is greater at the start of the braking interval than when the tape has nearly stopped. This means that ideally, the amount of differential voltage should be automatically variable during the braking cycle. One way to do

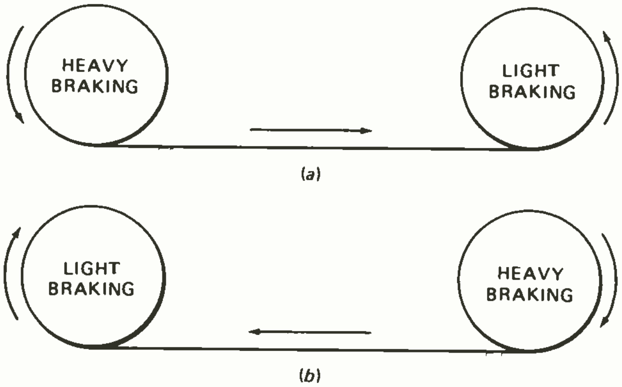


FIG. 8—IN FORWARD direction of tape travel (a), heavier braking is required on the tape-feed reel, while in the rewind mode (b), heavier braking must be applied to the take-up reel.

this is to have the series resistor value increase with time as the tape is stopping. Crown provides this effect very simply as shown in Figs. 10-a and 10-b, by using a device with a high positive-temperature-coefficient—an incandescent lamp assembly.

High-level relay switching

Three relays control the high-level AC line voltage used in the reel motors and in the pressure-roller (tape lifter) solenoid. The relays are all controlled by the logic circuits. Table I shows

MACHINE MODE	RELAYS			TYPICAL VOLTAGES		
	Op(RY1)	FWD(RY2)	(RWD(RY3)	TU Motor	PO Motor	Sol.(RY4)
STANDBY	0	0	0	+6 VDC	+16.5 VDC	0
PLAY (LG reel)	1	0	0	112 VAC 80 VAC	100 VAC 71 VAC	54 VDC 34.5 VDC
PLAY (SM reel)	1	0	0	78 VAC 55 VAC	69 VAC 49 VAC	54 VDC 34.5 VDC
F RWD	1	0	1	37 VAC	117 VAC	0
F FWD	1	1	0	117 VAC	37 VAC	0
RWD BRAKES	0	0	1	+52 VDC	+13 VDC	0
FWD BRAKES	0	1	0	+13 VDC	+52 VDC	0
RWD & FWD (Jockeying)	1	1	1	117 VAC	117 VAC	0

Test Conditions:
"0" = Relaxed State — Line Voltage = 117 VAC — No accessories being powered
"1" = Pulled-in State — Reels unloaded and free — Meter 20,000 Ω/volt VOM

TABLE I—Condition of the three high-level switching relays shown in Fig. 1 during various operating modes of the transport.

what happens in each of the machine's operating modes and how each relay applies the proper voltages to each reeling motor and the solenoid. The "operate" relay (RY1) is energized for all tape-moving modes. This relay determines whether the reel motors are powered by AC (moving) or DC (braking) voltages, and switches on the pressure roller/tape lifter solenoid when the other interlocking relays are de-energized. The rewind relay (RY3) chooses the proper braking differential and reel voltages for rewind, interlocks solenoid power, and activates the high-rewind braking mode. The forward relay (RY2) selects proper voltages for fast-forward, interlocks solenoid power, and activates the high-forward braking mode.

The logic circuitry

The logic circuits of the 800 transport use six Motorola MC-700P series IC's, ten transistors and eight diodes. Figure 10 is a block diagram of the controlling elements of the machine. The memory section of the computer takes and stores, in three flip-flops (IC5-b, -c; IC5-a, -d and IC6-b, -c), the last command given to it while erasing all previous commands. The stop bus is used to erase previous commands by resetting all three flip-flops to their standby state. Set-reset flip-flops are made of the MC-724P two-input gates by cross coupling their inputs and outputs, as shown in Fig. 11.

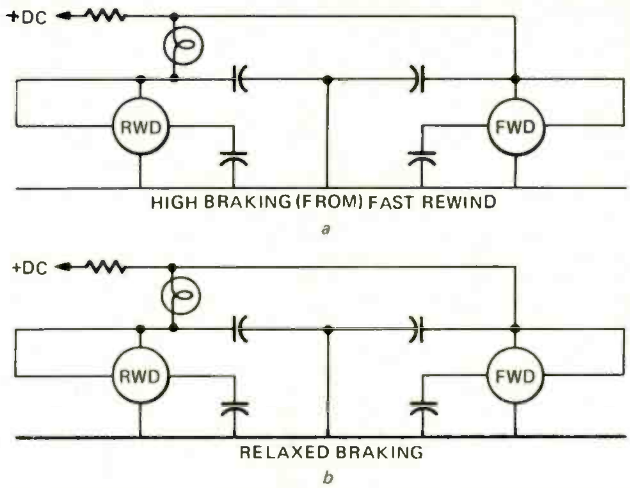


FIG. 9—DURING HIGH BRAKING (a), or relaxed braking (b), the differential voltage between reel motors varies automatically as the resistance of the incandescent lamp changes after a DC voltage has been applied.

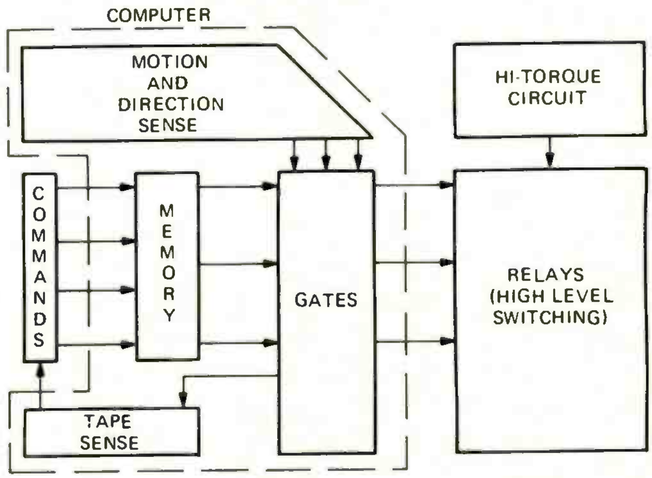


FIG. 10—CONTROLLING ELEMENTS of the Crown 800 tape transport.

The appropriate diode (D17, D18 or D19—Fig. 1), coupled from the play, rewind or forward commands provides a signal to the stop bus for each of these commands. In addition to furnishing the reset signal, the diode also causes the flip-flop to go to the desired state upon removal of the command because the reset command extinguishes before the input command, due to the forward voltage drop of the diode.

The "on" state of the rewind and fast forward flip-flops gives a high voltage output ("1") while the operate flip-flop provides a low voltage ("0") when in the "on" state. For any command other than stop, both flip-flop outputs are an "0". This is because both set and reset inputs of the associated flip-flop are activated—one by the command; the other by the stop bus. Therefore,

(continued on page 93)

DIGITAL CLOCK

(continued from page 35)

Obtaining parts

The liquid-crystal display and the C1200 LSI Computer Systems clock IC are specially designed components, not easily obtained through usual distribution channels. Accordingly, arrangements have been made to supply, by mail, a kit containing these special and other hard-to-get components of the Magiclock to readers of **Radio-Electronics.** The kit includes the etched and drilled printed-circuit board (MGC 48-7), Liquid-Crystal Display (MGC-50), 40-pin connector (MGC-116), C1200 MOS/LSI clock integrated circuit, 28-pin IC socket (MGC-28), and two 51-volt Zener diodes (MGC-51). The Magiclock kit, priced at $65.00, postpaid, is available from: Inventive Electronics, Box 53 Wykagyl Station, NY 10804.

Other components of the Magi-clock are available locally at any electronics distributor. Do not substitute values for those given, as voltage division is quite critical to proper operation.

Construction

Begin by laying out and soldering-in components other than the IC. Leave this component in its protective foam until everything else has been wired. (Be sure to read the precautions in handling before you attempt to install the IC.)

The use of a PC board makes construction easy. The sockets for the LSI integrated circuit and for the display, as well as all other components (except for D5 and D6) mount flat on top of the PC board, as shown in Fig. 5. Carefully observe the polarities of the six diodes and note that the two Zeners are soldered in place on the underside of the board. The display socket must be inserted with its part number facing the edge of the PC board so the display can plug in correctely. For S1 and S2, you can use either toggle switches or momentary-contact, normally open, pushbutton switches. For our Magiclock, we used toggle switches that nest neatly into cavities cut in the two wooden cleats, that support the PC board. Switch location is optional and not at all critical to proper operation of the clock.

Checkout

Perform these checks before installing IC1 or the LCD. *Do not install either of these components until everything is checked.*

After connecting the socket, the line cord, the wires to the switches, and all other components, give the PC board a careful visual once-over. Look for cold solder joints and potentially destructive solder or rosin bridges between pads. Protect your investment by making sure that the right resistor is in the right place. (Remember: you can blow the IC in a few microseconds if something's wrong and you don't bother to check.) If everything looks OK, you're ready for the recommended voltage checkout, which *must be done before you install the IC and the LCD in their respective sockets.*

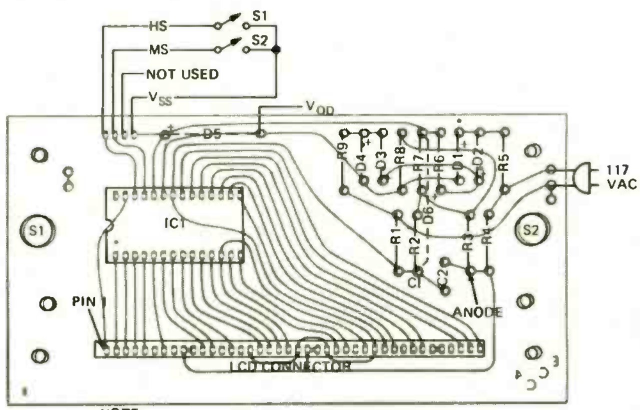
AC voltage checks

Plug the line cord into a 117-volt AC outlet and measure the voltage across R2 and across R3. You should read between 9 and 12 volts AC across each resistor, and the two readings should be about equal. If these voltages aren't right, remove power and check resistors R1, R2, R3, and R4. One or more may be the wrong value or out of tolerance.

Now, plug the line cord in again and measure the voltage across R1 and across R4. Each reading should be not less than 42, nor more than 48 volts AC. If either voltage is out of tolerance, remove power and thoroughly check resistance values in the divider.

DC voltage checks

Measure the voltage from the junction of R2 and R3 noted as point X on the schematic, to the VDD point on the PC board (see Fig. 4) You should read about −28 volts DC. (VDD is negative with respect to X.) Next, measure from the VSS point to X. You should read about +19 volts DC. (VSS is positive with respect to point X.) Now, measure from VDD to VSS. The meter should indicate the sum of the two previous readings (approximately 47 volts DC) with VSS positive with respect to VDD. *(Continued page 94)*



NOTE:
C2 IS NOT ON COMP SIDE OF BOARD, CONNECTS FROM C1 TO ANODE.

FIG. 5—COMPONENT LAYOUT of printed circuit board. An IC socket is used for easy assembly.

(continued from page 90)

in the case of the rewind and fast forward flip-flops, where a "1" output is necessary, diode OR gates are used to feed the commands around the flip-flops during the command (reset) interval. Diodes D20, D21, D22 and D23 do this job.

Each of the command inputs to the memory circuit has a capacitor to ground placed across it to protect the input from stray pulses and to assure that there is enough time for proper

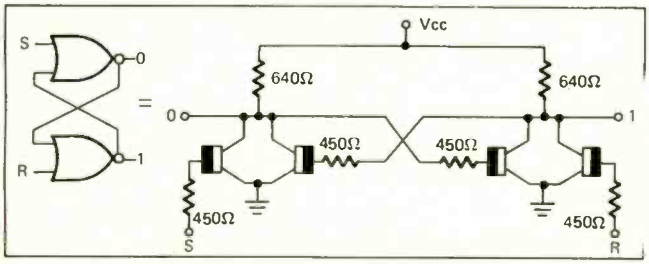


FIG. 11—A PAIR of two-input gates of a Motorola MC-724P IC are cross-connected as shown to form set-reset flip-flops.

setting of the flip-flop after removal of the command. Resistors are also used to shunt any external leakage currents to ground and to hold each input's stray positive pulse immunity at a maximum.

Each of the three high-level switching relays previously discussed is controlled by a transistor (Q13, Q14 or Q15) that in turn is controlled by its associated gating circuit. The 12 IC gates are the heart of the computer's interlocking and coordinating system. Each gate in Fig. 1 is identified by a number. If the gate is on in a given mode, its output is called "0" (low voltage); if off, it is assigned a "1" (high voltage) in Table II.

MACHINE MODE	GATES											
	1	2	3	4	5	6	7	8	9	10	11	12
STANDBY	0_s Possibly $\bar{x}$	0_s Possibly x	1	1	1	0_P	1	0_3	0_4	0_3	0_4	0_5
PLAY	$0_{6\bar{x}}$	0_6	1	1	0_6	1	1	0_3	0_4	0_3	0_4	1
REWIND	1	0_{Rx}	0_{1R}	1	0_5	0_{P8}	0_8	1	0_4	1	0_4	1
FORWARD	$0_{F\bar{x}}$	1	1	0_{2F}	0_F	0_{P9}	0_9	0_3	1	0_3	1	1
REWIND BRAKES	1	0_x	0_1	1	1	0_{P8}	0_8	1	0_4	1	0_4	0_5
FORWARD BRAKES	$0_{\bar{x}}$	1	1	0_2	1	0_{P9}	0_9	0_3	1	0_3	1	0_5
RWD & FWD (Jockeying)	0_F, Possibly $\bar{x}$ and/or s	0_R, Possibly x and/or s	0_R	0_F	0_{RF}	0_{P89}	0_{89}	1	1	1	1	1

TABLE II—On or off state of each of the twelve logic gates is tabulated for the various operating modes of the Crown 800 transport.

Whenever a gate output is "0", the set of numbers or letters following the "0" indicate which gate or control sources had supplied the necessary "1" output to its input to cause it to be "0". The letters of the control sources used in the table correspond to:

R=Rewind flip-flop in the memory circuit (1 = RWD)
F=Forward flip-flop in the memory circuit (1 = FWD)
P=Play flip-flop in the memory circuit (0 = FWD)
X=Direction sense circuitry (1 = RWD, 0 = FWD)
X=Direction sense circuitry (1 = FWD, 0 = RWD)
S=Motion Sense circuitry (1 = stop, 0 = Motion)

Because the last direction of machine motion is not unique in the standby or jockeying (fast forward followed quickly by fast rewind) states, gates 1 and 2 have X or $\overline{X}$ possible. Also, since there may not be any motion at all during jockeying, S is possible during this mode.

What does it all mean?

Clearly, modern electronic techniques, and particularly those from the world of digital electronics, play a vital part in the operation and performance of a top-performing tape transport such as Crown's 800. **R-E**

DIGITAL CLOCK

(continued from page 92)

Finally, measure the voltage drop across R6. The reading should be at least 8 volts, DC, but not more than 9 volts, DC.

If any reading is not in tolerance, carefully check each resistor value and replace any that are out of spec.

Installing the liquid crystal display

Disconnect the AC plug and carefully insert the LCD panel into its socket. Line it up so that contact areas on the lower edge of the glass are exactly opposite the spring contacts of the socket. In this way, you make sure that when the display is firmly seated, all socket contacts will properly mate with the LCD's connector edge. *Don't insert the IC yet.*

Plug in the AC line cord. If the LCD is properly inserted, the colon will appear on the display. If it doesn't, the LCD is not making proper contact. Reinsert the LCD or move it slightly to one side or the other, until the colon lights. Now pull out the AC plug again.

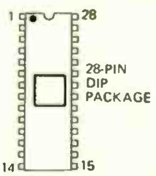
Installing the LSI clock chip

Having come this far, you are within minutes of seeing your Magi-clock in operation. Don't rush things now! Read and heed the next paragraph's precautions as you prepare to install IC1.

Any MOS IC device must be handled carefully, for it can be damaged by high-

PIN CONNECTIONS C1200

Pin No.	Function	
1	C4	LCD SEGMENT OUTPUTS
2	F3	
3	G3	
4	E3	
5	D3	
6	C3	
7	B3	
8	A3	
9	F2	
10	G2	
11	E2	
12	D2&A2	
13	C2	
14	B2	
15	F1	
16	G1	
17	E1	
18	D1	
19	C1	
20	B1	
21	A1	
22	CI	60 Hz COUNT INPUT
23	VDD	SUPPLY
24	VSS	SUPPLY
25	MS	MINUTE SET INPUT
26	HS	HOUR SET INPUT
27	SEC	ONE SECOND FLASH OUTPUT
28	AM	AM OUTPUT (NOT USED)



PIN FUNCTION and pin identification for the C1200 clock chip from LSI Computer Systems.

voltage static charges produced by casual, ordinary handling. For this reason, it is shipped with all of its pins pressed into a piece of conducting foam rubber, where it should remain until you're ready to plug it into the socket on the PC board. Don't handle the device immediately after you walk across a dry rug with rubber-soled shoes, comb your hair or put on a nylon sweater, for you can easily build up static charges of several thousand volts and unwittingly ZAP the IC. Before removing the IC from its protective foam, touch a grounded object to discharge any body capacitance charge. *Never, never, never attempt to insert or remove the MOS IC while power is on.* If you need to resolder a connection after the IC is plugged-in, run a ground wire to the iron's tip to drain away destructive charges. Follow these precautionary steps and your IC is sure to survive.

After pulling out the power line plug, wait a few seconds for filter capacitor C1 to dissipate its charge through R6, R7 and R8. Now insert the integrated circuit into its socket. *Be sure to plug it in correctly as shown in Fig. 5.* If you insert the socket incorrectly, you'll damage it the instant power is applied—so, do it right the first time.

Connect the AC line cord. A random number display will appear on the LCD. It may even flash at a 1-Hz rate. Now, you're ready to set the time and that is *very* simple.

Setting time and using your clock

Close the MINUTE SET switch and you will see the minutes change rapidly—two minutes each second. As the correct minute digit appears, open the switch. The hour digits are set the same way with the HOUR SET switch and that is all there is to it!

The clock can be set precisely from the time signal sent over the radio or telephone. Close the HOUR SET and MINUTE SET switches at the same time. Release them both at the instant the time signal is heard. Then set the minutes and hours independently to the correct time as before. The clock is now accurately synchronized to the time tone.

For elapsed time indication close both switches and release them simultaneously. The display will start from 0:00 and count elapsed time in one minute steps.

If there has been a power interruption (as is theoretically the case when the clock is first plugged in) the entire display may flash at a 1-Hz rate signalling that the time displayed is not correct. When either time set switch is activated, the display will stop flashing.

If you plug in the clock immediately after bringing it indoors on a very cold day, the display may not read correctly—one or more "extra" segments may light up. This happens because of condensation between the IC or LCD sockets' closely spaced "lands" on the PC board, or moisture between the contact areas on the LCD itself. Normal drying in warm room air should alleviate the problem. Plug in the clock and let it operate for 15 to 30 minutes to restore normal operation.

Back-lighting the display

If you add a small fluorescent or incandescent light source *behind* the LCD the visibility of the large time numerals will improve. The light should be mounted out of direct line of sight, so as to cast light on the display, without the light-source itself being visible through the LCD panel. An angle-mounted plane mirror is a good choice for reflecting light onto the display. Choose one about the same width as the LCD panel and about half its height. Alternatively, aluminum foil can be used as a flexible, easily worked reflector. **R-E**

next month

SEPTEMBER 1975

- **Build This Electronic Doorbell**
  IC project uses a PROM to "record" up to 32 musical notes. Two circuit boards make the unit easy to build and you program the particular music you want your unit to play.

- **Installing TV-MATV Antennas**
  Put antenna theory to practical use to solve reception problems when you put up that next TV-MATV antenna system.

- **All About Oscilloscopes**
  Part IV: The final section of this article describes many interesting oscilloscope applications. Bet you'll find at least one you've never seen before.

- **Hi-Fi Lab Test Reports**
  Two more new reports on some of the latest hi-fi gear around.

- **Signal-To-Noise—What does it mean?**
  If you have always wondered what signal-to-noise ratio is and how it affects hi-fi sound, don't miss this article by Len Feldman, R-E's Contributing High-Fidelity Editor.

PLUS

Jack Darr's Service Clinic
Step-By-Step Troubleshooting Charts
State-Of-Solid-State
Radio-Electronics' Replacement Japanese Transistor Directory

service questions

NO SYNCS

This was one of mine. "Friend" (?) brought in large Quasar TS-938. Says "I've changed all the boards that would have anything to do with it, and I've still got problems!". It looked as if there was no horizontal or vertical sync. So, we drove it into the shop. "Up scope!".

I found plenty of horizontal sync on Q5, the sync separator; also at the output of the sync amplifier. However, it was jittering badly. The video signal to the sync separator was also jittering. The scope showed an odd glitch on the horizontal sync. However, the oscillator itself was apparently in good condition. The picture never fell into slanting lines, just floated back and forth.

I saw what seemed to be enough horizontal sync at the output terminal on the sync panel, so let's see if it is getting to the horizontal-output panel. Tracing this through the cabling, I pulled the output panel. Oh, oh! One of the numerous contact pins in the vertical array on the left side was *pushed back* at least half an inch. Tilting the panel, my little flashlight showed that the contact this was supposed to make was plainly labelled HOR SYNC INPUT! A little tricky work with a pair of long-noses pushed the pin back in line with the rest. Putting the board carefully back, the trouble was over! Evidently this pin had been slightly bent, and when the board was replaced, it got pushed back far enough so that it wasn't making contact at all. The jitter of the video signal was probably due to the upsetting of the AGC.

ELECTRIC FENCE

My solid-state electric fence charger went out. I found an open electrolytic capacitor; the one that discharges to produce the shock. It's a 100-mF 150 volt type. I replaced it with a 150-mF 200-volt type. Is this OK? Seems to work about the same as it did.—B.R., Temple, TX.

I'd buy that any day. You can never go wrong by choosing a replacement capacitor with a higher voltage rating than the original. In most applications, you can generally use a larger capacitance than the original. Just don't use a smaller one or one with a lower voltage rating. **R-E**

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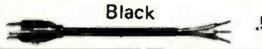

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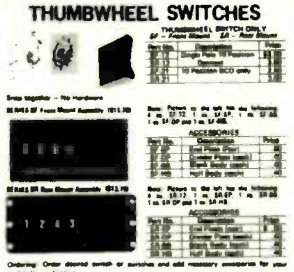

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18 pin	.46	.41	.37	40 pin	1.25	1.13	.93
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14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
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18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

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14 pin	.46	.42	.38	28 pin	1.40	1.25	1.10
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18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea:	10 OHM 12 OHM 15 OHM 18 OHM 22 OHM / 27 OHM 33 OHM 39 OHM 47 OHM 56 OHM	1/4 WATT 5% = 50 PCS.
ASST. 2	5 ea:	68 OHM 82 OHM 100 OHM 120 OHM 150 OHM / 180 OHM 220 OHM 270 OHM 330 OHM 390 OHM	1/4 WATT 5% = 50 PCS.
ASST. 3	5 ea:	470 OHM 560 OHM 680 OHM 820 OHM 1K / 1.2K 1.5K 1.8K 2.2K 2.7K	1/4 WATT 5% = 50 PCS.
ASST. 4	5 ea:	3.3K 3.9K 4.7K 5.6K 6.8K / 8.2K 10K 12K 15K 18K	1/4 WATT 5% = 50 PCS.
ASST. 5	5 ea:	22K 27K 33K 39K 47K / 56K 68K 82K 100K 120K	1/4 WATT 5% = 50 PCS.
ASST. 6	5 ea:	150K 180K 220K 270K 330K / 390K 470K 560K 680K 820K	1/4 WATT 5% = 50 PCS.
ASST. 7	5 ea:	1M 1.2M 1.5M 1.8M 2.2M / 2.7M 3.3M 3.9M 4.7M 5.6M	1/4 WATT 5% = 50 PCS.

Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
California Residents — Add 6% Sales Tax
Write for FREE 1975S Catalog — Data Sheets .25¢ each

JAMES

P.O. BOX 822, BELMONT, CA. 94002
PHONE ORDERS — (415) 592-8097

IC'S EXAR KITS

FUNCTION GENERATOR KIT

features sine, triangle and square wave; THD 0.5% typ.; AM/FM capability

XR-2206KA $19.95
Includes monolithic function generator IC, PC board, and assembly instruction manual.

XR-2206KB $29.95
Same as XR-2206KA above and includes external components for PC board.

TIMERS		
XR-555CP	Monolithic Timer	$ 1.10
XR-320P	Precision Timer	1.55
XR-556CP	Dual-555 Timer	1.85
XR-2556CP	Dual Timing Circuit	3.20
XR-2240CP	Programmable Counter/Timer	4.80
PHASE LOCKED LOOPS		
XR-210	FSK Demodulator	5.20
XR-215	High Frequency PLL	6.60
XR-567CP	Tone Decoder (mini DIP)	1.95
XR-567CT	Tone Decoder (TO-5)	1.70
STEREO DECODERS		
XR-1310P	PLL Stereo Decoder	3.20
XR-1310EP	PLL Stereo Decoder	3.20
XR-1800P	PLL Stereo Decoder	3.20
WAVEFORM GENERATORS		
XR-205	Waveform Generator	8.40
XR-2206CP	Monolithic Function Generator	5.50
XR-2207CP	Voltage Controlled Oscillator	3.85
OTHER EXAR IC'S		
XR-1468CN	Dual + 15V Tracking Regulator	3.85
XR-1488N	Quad Line Driver	5.80
XR-1489AN	Quad Line Receiver	4.80
XR-2208CP	Operational Multiplier	5.20
XR-2211 CP	FSK Demodulator/Tone Decoder	6.70
XR-2261	Monolithic Proportional Servo IC System w/4 ea. Driver Transistor	3.79

Special Requested Items

8008 Processor	$29.95	8267	$ 4.00	4024P*	$2.25
1101 256 x 1 RAM	2.25	2513*	11.00	N8T97	3.00
2102 1024 RAM	5.50	2518	7.00	MC1741	4.00
AY5-1013 UART	9.95	2519	4.00	MC4044	4.50
RC4194 TK	5.95	2524*	3.50	CA3130S	1.49
8101	18.00	2525	7.00	40410	1.75
8263	7.00	2533	11.85	40673	1.75

DIODES

(Zener) TYPE	VOLTS	W	PRICE	(Rectifier) TYPE	VOLTS	W	PRICE
IN746	3.3	400m	4/1.00	IN4003	200 PIV	1 AMP	.10
IN751A	5.1	400m	4/1.00	IN4004	400 PIV	1 AMP	.10
IN752	5.6	400m	4/1.00	IN3600	50	200m	6/1.00
IN753	6.2	400m	4/1.00	IN4148	75	10m	15/1.00
IN754	6.8	400m	4/1.00	IN4154	35	10m	12/1.00
IN965B	15	400m	4/1.00	IN4734	5.6	1w	.28
IN5232	5.6	500m	.28	IN4735	6.2	1w	.28
IN5234	6.2	500m	.28	IN4736	6.8	1w	.28
IN5235	6.8	500m	.28	IN4738	8.2	1w	.28
IN5236	7.5	500m	.28	IN4742	12	1w	.28
IN456	25	40m	6/1.00	IN4744	15	1w	.28
IN458	150	7m	6/1.00	IN1183	50 PIV	35 AMP	1.60
IN485A	180	10m	5/1.00	IN1184	100 PIV	35 AMP	1.70
IN4001	50 PIV	1 AMP	.09	IN1186	200 PIV	35 AMP	1.80
IN4002	100 PIV	1 AMP	.10	IN1188	400 PIV	35 AMP	3.00

TRANSISTORS

MPS-A05	5/$1			2N3905	4/$1
2N918	.25	2N2906A	4/$1	2N3906	4/$1
2N2219A	3/$1	2N2907A	5/$1	PN4249	4/$1
2N2221	4/$1	2N3053	2/$1	PN4250	4/$1
2N2222A	5/$1	2N3055	.95	2N4409	5/$1
2N2369	5/$1	2N3725A	2/$1	2N5129	.19
2N2369A	4/$1	2N3903	5/$1	2N5139	.19
2N2484	4/$1	2N3904	4/$1	C106B1-SCR	2/$1

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10pf	.05	.04	.03	.001	.05	.04	.035
22 pf	.05	.04	.03	.0047	.05	.04	.035
47 pf	.05	.04	.03	.01	.05	.04	.035
100 pf	.05	.04	.03	.022	.06	.05	.04
220 pf	.05	.04	.03	.047	.06	.05	.04
470 pf	.05	.04	.035	.1	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

± 20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1	35V	.28	.23	.17	1.5	35V	.30	.26	.21
.15	35V	.28	.23	.17	2.2	25V	.31	.27	.22
.22	35V	.28	.23	.17	3.3	25V	.31	.27	.22
.33	35V	.28	.23	.17	4.7	25V	.32	.28	.23
.47	35V	.28	.23	.17	6.8	25V	.36	.31	.25
.68	35V	.28	.23	.17	10	25V	.40	.35	.29
1.0	35V	.28	.23	.17	15	25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead					Radial Lead				
.47	50	.15	.13	.10	.47	25	.15	.13	.10
1	50	.16	.14	.11	.47	50	.16	.14	.11
3.3	50	.15	.13	.10	1	16	.15	.13	.10
4.7	25	.16	.14	.12	1	25	.16	.14	.11
10	25	.15	.13	.10	1	50	.16	.14	.11
10	50	.16	.14	.12	4.7	16	.15	.13	.10
22	25	.17	.15	.12	4.7	25	.15	.13	.10
22	50	.24	.20	.18	4.7	50	.16	.14	.11
47	25	.19	.17	.15	10	16	.14	.12	.09
47	50	.25	.21	.19	10	25	.15	.13	.10
100	25	.24	.20	.18	10	50	.16	.14	.12
100	50	.35	.30	.28	47	50	.24	.21	.19
220	25	.32	.28	.25	100	16	.19	.15	.14
220	50	.45	.41	.38	100	25	.24	.20	.18
470	25	.33	.29	.27	100	50	.35	.30	.28
1000	16	.55	.50	.45	220	16	.23	.17	.16
2200	16	.70	.62	.55	470	25	.31	.28	.26

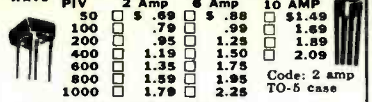
Circle 98 on reader service card

4½ DIGIT DIGITAL VOLTMETER DVM CHIP

Type MM5330 by National utilizes P channel low-threshold enchancement mode devices and ion implanted depletion mode devices. Provides logic circuit for 4½ digit DVM. All logic for four decade counters, a divide by four counter, a divide by two counter for over-range blanking, latches for all counter stages, an output ROM to generate BCD to 9's complement BCD of the latches and a module 4 counter to sequentially present each of decade latches thru ROM to the BCD outputs plus four outputs to indicate which decade is display. A reset for all counter stages, transfer pulse generator to set the latches. To 400 Khz operation. TTL compatible. With instruction sheets and diagram on "how-to-build a 4½ digit DVM". Ideal with our Litronix ½" single, 1½" and dual digits. 16-pin DIP. Cat. No. 92CU2488

$14.95

FULL WAVE EPOXY SILICON BRIDGE RECTIFIERS



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

Code: 2 amp TO-5 case

6 Amp 1/2 x 1/2 x 3/16 sq.

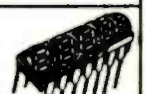
RAYTHEON-RCA NATIONAL SIGNETICS LINEAR IC'S

Buy 3 — Take 10%

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

Type	Sale	Type	Sale
☐ LM300	$ .69	☐ LM566	2.68
☐ LM301	.29	☐ LM567	2.50
☐ LM302	.69	☐ LM702	.49
☐ LM304	.79	☐ LM703	.41
☐ LM305	.89	☐ LM703M	.41
☐ LM308	1.05	☐ LM709	.25
☐ LM309H	1.05	☐ LM710	.29
☐ LM309K	1.50	☐ LM711	.29
☐ LM310	1.10	☐ LM723	.61
☐ LM311	.99	☐ LM733	1.75
☐ LM318	1.75	☐ LM741	.31
☐ LM319	1.19	☐ LM741CV	.31
☐ LM320*	1.25	☐ LM747(D)	.69
☐ LM322	1.75	☐ LM748	.35
☐ LM324 (Q)	1.85	☐ LM753	1.79
☐ LM339 (Q)	1.45	☐ LM1303	.79
☐ LM340*	2.50	☐ LM1304	1.00
☐ LM341-T*	1.75	☐ LM1307	.79
☐ LM350	.69	☐ LM1458(D)	.69
☐ LM370	1.05	☐ LM1496	.99
☐ LM371	1.05	☐ LM1800	3.50
☐ LM373	1.95	☐ RC2556(D)	2.25
☐ LM374	1.95	☐ CA3026	.59
☐ LM376	.49	☐ CA3045	.59
☐ LM377	2.50	☐ CA3054	.59
☐ LM380-8	1.10	☐ CA3065	.59
☐ LM380	1.39	☐ CA3082	.59
☐ LM381	1.69	☐ LM3900	.49
☐ LM382	1.69	☐ RC4136(Q)	1.95
☐ LM531	1.95	☐ RC4195	2.50
☐ LM532	1.95	☐ LM4250C	2.10
☐ LM533	1.95	☐ LM7520	.59
☐ LM555	.88	☐ LM7521	.59
☐ LM556	2.50	☐ LM7522	.59
☐ LM558(D)	.69	☐ LM7523	.59
☐ LM560	2.50	☐ LM7524	.59
☐ LM561	2.50	☐ LM7525	.59
☐ LM562	2.50	☐ LM7528	.59
☐ LM565	2.50	☐ LM7529	.59
		☐ LM7535	.59

3 TO 5 DIGIT INSTRUMENT READOUTS

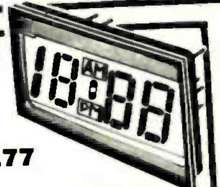


- Color Red
- Fits into 14-pin IC sockets
- 3V @ 10 mils per segment.

Type	Size	Digits	Sale	Special
☐ DL-33	.08G	3	$1.75	3 for $5.
☐ 5082-4	.11	4	2.98	3 for $6.
☐ 5082-5	.11	5	2.49	3 for $7.

G—With built-on magnifier.

4-DIGIT AM-PM FLUORESCENT CLOCK PANEL



"PANEL OPTICS" Made By TUNG-SOL D2004

$7.77

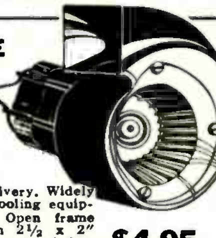
YOU ASKED FOR IT! Found only at Poly Paks at this l-o-w price! It's ONLY 1 3/4 x 1 3/16 x 3/8" deep panel. Designed specifically for our MM-5316 fluorescent driving clock chip. Indicates 4-digits, AM-PM, pulsating second indicator, requires minimum of parts to build. Color: BLUE-GREEN; you can use RED or GREEN filters. Character height: 0.5". Filament voltage is 1.75 VAC or DC @ 160 mils. Anode voltage 25V @ 250 microamps per segment. With spec sheets, clock construction diagrams, P.C. board layouts, specs. A DIGITAL CLOCK BUILDER'S SPECIAL.

SCRS! TRIACS! QUADRACS! SAME PRICE SALE!

10-Amp Power Tab Plastic Units

PRV	Sale
☐ 50	$ .78
☐ 100	.95
☐ 200	1.25
☐ 300	1.50
☐ 400	1.95
☐ 500	2.25
☐ 600	2.50

ALLIANCE SHADE POLE BLOWER 115VAC



Offers maximum efficiency in quiet air delivery. Widely used in hearing, ventilating, exhausting, cooling equipment. Direct drive motors 100 CFM. Open frame shaded pole motor, driving a Torrington 2½ x 2" bladed wheel, square 2¼ x 2" intake, 2½ outlet holes. Overall size of housing 5½ x 2½ x 5" deep. Wt. 2 lbs. 3 - 10/32 mtg. holes.

$4.95

INDUSTRIAL SPEED CONTROL ☐ $4.95

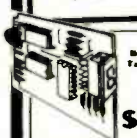
A $30 item from G.E. Model 533A (made for Xerox) that controls home, shop and industrial lighting tool A very elaborate circuit for controlling many electrical and electronic devices. Easily controls speeds of electric drills, brush type motors, etc. 115vac, rated at 1100 watts. With variable speed or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

GAS DISCHARGE 9-DIGIT READOUT $1.98

☐ 3 for $5

By Sperry Rand, type SP-425-09. With 8 roving decimals, and a fixed decimal, 7-segment. Color: ORANGE. Anode voltage 100 to 190V. Properly multiplexed, to a 18-pin connector (soldering too). For calculators, etc. Glass window. Character height: .27. Readout only 3 x ¾".

LED MITY DIGIT "DCM'S"



Buy 3 — Take 10%

☐ Only **$8.88**

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

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

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

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

GAS DISCHARGE DISPLAY POWER SUPPLIES

Only ☐ $4.95

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

LED Revolution!

MONSANTO! XCITON! LITRONIX! OPCOA!

5 for $1

.340x.260 Jumbo	.240x.200 Medium
☐ Red	☐ Red
☐ Green	☐ Yellow
☐ Yellow	☐ Green
☐ Amber	☐ Amber
☐ Clear	☐ Clear

.340x.160 Medium	.210x.125 Micro
☐ Red	☐ Red
☐ Green	☐ Green
☐ Yellow	☐ Yellow
☐ Amber	☐ Amber

Micro (Axial) MV-50 style
☐ MV-50 Clear . . . . 10 for $1.
☐ MV-55 Red . . . . . . 6 for $1.

JUMBO 0.6" MITY DIGIT DCM

MAN-6. Same electrical specs as the MAN-1. Measures 1 x ⅞ x ⅛" encapsulated in red epoxy lens. Outperforms all reflective bar types. MORE BRILLIANT! Made for distance and wide-angle viewing. Fits into standard 14 pin DIP socket. Kit includes MAN-6, right angle IC socket, edge connector, pc board, assorted resistors and capacitors, SN7475, SN7447, SN7490, Molex sockets and booklet. ☐ 9.95

☐ Same as above except uses MAN-64, 0.4 ALL LED readout, MAN-1 characteristics . . . . Only $8.88

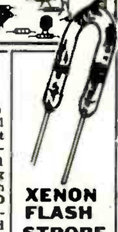
'BEEPER" AND "DATER' CLOCK ON THE CHIPS

☐ MK50250 BEEPER $ 8.50

Imagine a chip (MK50250) "Beepin" and audible alarm! All others are external. It also features internal brightness control. The CT7001 requires external triggering of alarm, date of the month and direct drive to LED readouts. Both require minimum current drain and voltages, for either 4 to 6 LED readouts, 12 or 24 hours, AM and PM.

CT7001 Alarm and Data $6.95

XENON FLASH STROBE TUBE



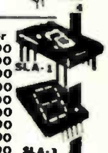
☐ $1.95

7-SEGMENT READOUT SALE!

- Up to 20 mils per seg. at 5V.
- All fit into 14-pin IC socket.

Type	Size	Color	Sale	3 for
☐ MAN-1	.27	Red	$2.50	$6.00
☐ MAN-3MA	.12	Red	.69	2.00
☐ MAN-4AB	.27	Red	1.95	5.00
☐ MAN-5	.27	Green	1.50	4.00
☐ MAN-6	.6	Red	4.50	12.00
☐ MAN-64	.4	Red	3.50	9.00
☐ MAN-7	.27	Red	1.00	2.50
☐ MAN-8	.27	Yellow	1.50	4.00

ALL ABOVE BY MONSANTO



Type	Size	Color	Sale	3 for
☐ SLA-1	.33	Red	$1.95	$5.00
☐ SLA-1	.33	Green	1.95	5.00
☐ SLA-1	.33	Yellow	1.95	5.00
☐ SLA-3	.7	Green	4.95	12.00
☐ SLA-3	.7	Yellow	4.95	12.00
☐ 707	.33	Red	1.95	5.00
☐ 704A	.33	Red	1.95	5.00
☐ 701C	.33	Red	1.50	3.00
☐ FND-70	.25	Red	1.50	3.00

A—Common Cathode, others Common Anode
B—With bubble magnifier
C—Plus or Minus 1

TOUCH TONE KEYBOARD KIT $4.95

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

20-WATTS

PEAK AUDIO OUTPUT

SOLID STATE TUNER AMPLIFIER!

$39.95

This unit is designed same as 60 watt tuner amp unit, except 20-watt tuner amp

AM-FM-MULTIPLEX

"BLASTAWAY" ON 1N4000 RECTIFIER PRICES

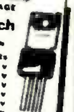
Type	PIV	Sale
☐ 1N4001	50	10 for 45c
☐ 1N4002	100	10 for 55c
☐ 1N4003	200	10 for 65c
☐ 1N4004	400	10 for 75c
☐ 1N4005	600	10 for 85c
☐ 1N4006	800	10 for 99c
☐ 1N4007	1000	10 for 1.29

NATIONAL LM-340T VR's

- TO-220 Case • 1 Amp
- POSITIVE VOLTAGE

$1.75 Each

Buy 3 — Take 10%



Type	Volts
☐ LM-340-05T	5 v
☐ LM-340-06T	6 v
☐ LM-340-08T	8 v
☐ LM-340-12T	12 v
☐ LM-340-15T	15 v
☐ LM-340-18T	18 v
☐ LM-340-24T	24 v

60-WATT STEREO AM-FM-MULTIPLEX TUNER AMPLIFIER!

$55 WITH ESCUTCHEON ☐

60 WATT PEAK AUDIO OUTPUT

- AM-FM-MUX-DIAL indicators!
- All Solid State, Printed Circuitry
- Slide Rule Dial
- All Purpose, All Family System!
- 100-Watts music power

Has so many unique and different functions, makes it the finest system of its kind at the usual Poly Pak economy prices. Features: 4-speaker system, built-in FM antenna, record player jacks on separate panel. Another external panel consists of provisions for external FM and AM antenna, "satellite" speakers to provide 4-speaker ground, jacks for connecting a tape recorder to radio tuner or phono of systems to record. Lower inputs for connecting tape deck that will play back thru the internal amplifier for systems. AC jack for phono power connection. RED, GREEN and CLEAR indicators for Phono, AM, and FM respectively. Includes red indicator on front panel for STEREO indicator. Has separate input to plug into mike, guitar and other musical instruments as well as another jack for plugging in a pair of stereo headphones.

Has the following 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.

MICROPROCESSORS! ROMS! RAMS! MEMORIES!

☐ 8008 Microprocessor	$44.00
☐ 8080 Super 8008	250.00
☐ 2102 1024 Static RAM	.95
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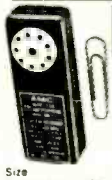

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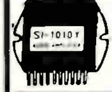

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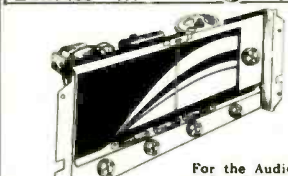

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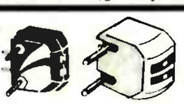
For the Audiophiles who are seeking an economy hi-fi AM only at our give-away price! Never advertised before. Same quality and construction as our 20W to 60W units. Features: 4 controls; Tuning, Tone, ON/OFF Volume, Circuit Switch (AM-phono). 2-Speaker stereo effect system. 6-ft. power cord. Phono cables, with hookups. 115 VAC, 60 cycles. No escutcheon. Size: 10 5/8 x 5 5/8 x 3 1/2" deep. Wt. 3 lbs.

□ **$19.95 AM-FM**

Never before have we ever seen such a combination of AM and FM with built-in high quality at such a low price. A "natural" for the economy-minded Audiophile. Features: Tuning Tone, ON/OFF Volume, Balance, Circuit Switch (AM, FM, FM-AFC, phono). 2-Speaker stereo effect system. 6-ft. power cord. Phono cables, with hook-ups. 115 VAC, 60 cycles. No escutcheon. Size: 13 x 7 x 3 1/2" deep. Wt. 3 lbs.

4-TRACK STEREO TAPE HEADS BY RCA

AS LOW AS **$1.98**



□ RECORD/PLAY	$3.95	3 for $9.
□ ERASE	1.98	3 for $5.
□ Record & Erase Combo	4.95	

Special purchase of these popular RCA replacement stereo heads, RECORD and ERASE, for all tape recorders and decks . . . anywhere. RCA Magnetic Record/Play part #946634-1, with 4 lugs in back. Metal enclosed. ERASE head RCA part #144161, in bakelite case.

LOWEST PRICES IN U.S.A.! LIMITED TIME OFFER!

9-FUNCTION, 8-DIGIT MEMORY CALCULATOR KIT

It's the easiest multi-function kit today!

- DOUBLE MEMORY
- Percent, Constant, Display Restore
- 4-Function Arithmetic
- 22 KEYS!

$16.95

EASY TO PUT TOGETHER! You bet it is . . . imagine no resistors, capacitors, but it **ONLY REQUIRES 2 CHIPS and a READOUT!** How's that for simplicity? The 2 Memory keys are MS Memory Storage and MR Memory Recall (requires very little soldering). The display restore key is to conserve battery life. Your display on panel shuts off 25 seconds after the last operation. By depressing "D" key, the display is restored! Uses 6 N cell batteries. Red decimal appears on left to show when batteries need replacement, or charging. Has Decimal, Clear, Constant, Percent, and arithmetic key red, white and blue colors. Lightweight, pocket size 5 1/4 x 3 x (2" at back side) x 1 1/4" front side of angular display panel black case. Nifty unit for business, school, home, and for the youngsters. Slips into any pocket, briefcase with ease. Easy-to-understand pictoral instruction booklet and how-to-use-book. **AC/DC too!**

KIT INCLUDES: case, 22-key keyboard kit, ON-OFF switch (part of keyboard) PC board, driver and memory calculator chips, 9-digit "bubble" magnifier LED array, array cable, AC adapter jack & wires, battery case, 6 battery card display, instruction and pictorial step-by-step construction booklet.

8 BRITE DIGITS

THE SIMPLEST! FINEST! SMALLEST!

6-FUNCTION AC-DC CALCULATOR KIT!

$14.95

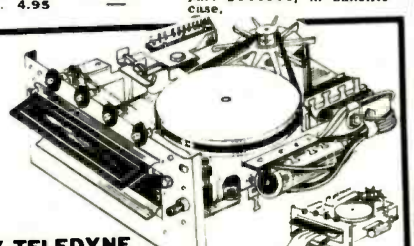
- Lightweight, pocket size Extra large display
- 6 functions plus, minus, times, percentage, constant
- Floating decimal
- Chain and Mix calculations
- Simplified indexing
- Mark up and Mark down
- Constant multiplication and division
- AC adaptor jack

Designed specifically for Poly Paks under the Daltone 80 brand. IMAGINE! only 2 1/2 x 1 x 4 1/2". Slides easily into your vest pocket, brief case, or handbag. We hunted everywhere to find a calculator kit that can be small, do the many functions, with fine engineering design and SIMPLE TO BUILD! WHY? Because it has the fewest parts in a kit. Imagine the pc board only has the chip, 4 resistors, two transistors, two driver ic's with the 9 digit readout. SIMPLE! You bet it is. The entire kit is even packed in a multicolor attractively designed box that in itself tells the mini calculator story. Kit includes: attractive black case with red filter; Flex Key (type 20SK-66) 18 key keyboard that measures only 2 1/2 x 2" with 2 switches, one for ON-OFF, one for K constant; MAIN pc board; readout board; famous Cal Tech 5030 26-pin calculator chip; two 75491 ic drivers; 9 digit array; ac jack; 9 Volt battery connector resistors; two transistors; back protective plate; necessary wire plugs; easy instructions. (Less 9 volt standard battery and AC adapter) **EASIEST KIT TO BUILD**

First Time!

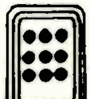
"QUAD" TAPE DECK

$19.95 BY TELEDYNE PACKARD-BELL



JUST IN . . . The "QUADS". Use for either 8-track or Quad tapes. An audiophile economy exclusive by Poly Paks. Same type found in the most expensive tape players, tuners, etc. It's a complete Quad system, featuring 4-channel preamp . . . all the cables necessary to just plug into any stereo quad amplifier or even our 20 & 60-watt tuner amplifier systems (see elsewhere in this catalog). Insert a cartridge to turn on deck. Enjoy up to 80 minutes of non-stop, non-repeat stereo or quad. Remove cartridge deck automatically shuts off. Other features: 4-program indicator lights, automatic or manual program change, push-button channel selector switch, built-in triggering switch that enables you to automatically use 8-track or quad tapes; heavy-duty flywheel for WOW & FLUTTER PROOF sound; flapping front panel tape door mounting front panel flange. Heavy duty cool-proof 115 VAC motor. Requires external 12 VDC supply, for all electronics. Includes schematic, hookups, all cables. Size: 6 1/2 x 6 1/2 x 3 1/2". IT'S READY TO GO!

POSTAGE STAMP MOBILE MIKE SPKR



$1.98

This unit is not advertised — anywhere! Made for Motorola Communications at the original cost of $4.50 each (for insertion in their Walkie Talkie Program). It's a 60-ohm imp MIKE. It's an excellent speaker too, covering broad range in sound. Extremely well-made.

Terms: add postage **Rated:** net 30
Phone Orders: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield, Mass. (off Water Street) C.O.D.'S MAY BE PHONED

□ **20c CATALOG** on Fiber Optics, 'ICs', Semi's. Parts

MINIMUM ORDER — $4.00

POLY PAKS

P.O. BOX 942R, LYNNFIELD, MASS. 01940

Circle 103 on reader service card

5% OFF ON ORDERS OVER $50.00
10% OFF ON ORDERS OVER $100.00
15% OFF ON ORDERS OVER $250.00

TTL

7400	$ .16	7451	$ .21	74154	$1.25
7401	.17	7453	.20	74155	1.07
7402	.17	7454	.17	74156	1.07
7403	.17	7460	.17	74157	.99
7404	.19	7464	.35	74158	1.19
7405	.20	7465	.35	74160	1.39
7406	.35	7470	.30	74161	1.25
7407	.35	7472	.30	74162	1.39
7408	.19	7473	.35	74163	1.39
7409	.23	7474	.35	74164	1.59
7410	.16	7475	.57	74165	1.59
7411	.26	7476	.39	74166	1.49
7413	.55	7483	.99	74170	2.30
7415	.35	7485	1.10	74173	1.49
7416	.35	7486	.40	74174	1.62
7417	.35	7489	2.48	74175	1.39
7420	.17	7490	.62	74176	.89
7422	.26	7491	.97	74177	.84
7423	.29	7492	.71	74180	.90
7425	.27	7493	.60	74181	2.98
7426	.26	7494	.94	74182	.79
7427	.29	7495	.79	74184	2.29
7430	.20	7496	.79	74185	2.29
7432	.23	74100	1.30	74187	5.95
7437	.35	74105	.44	74190	1.35
7438	.35	74107	.40	74191	1.35
7440	.17	74121	.42	74192	1.25
7441	.98	74122	.45	74193	1.19
7442	.77	74123	.85	74194	1.25
7443	.87	74125	.54	74195	.89
7444	.89	74126	.71	74196	1.25
7445	.89	74141	1.04	74197	.89
7446	.93	74145	1.04	74198	1.79
7447	.80	74150	.97	74199	1.79
7448	1.04	74151	.79	74200	5.90
7450	.20	74153	.99		

LOW POWER TTL

74L00	$ .25	74L51	$ .29	74L90	$1.49
74L02	.25	74L55	.33	74L91	1.45
74L03	.25	74L71	.25	74L93	1.69
74L04	.25	74L72	.39	74L95	1.69
74L06	.25	74L73	.49	74L98	2.79
74L10	.25	74L74	.49	74L164	2.79
74L20	.33	74L78	.79	74L165	2.79
74L30	.33	74L85	1.25		
74L42	1.49	74L86	.69		

HIGH SPEED TTL

74H00	$ .25	74H21	$ .25	74H55	$ .25
74H01	.25	74H22	.25	74H60	.25
74H04	.25	74H30	.25	74H61	.25
74H08	.25	74H40	.25	74H62	.25
74H10	.25	74H50	.25	74H72	.39
74H11	.25	74H52	.25	74H74	.39
74H20	.25	74H53	.25	74H76	.49

8000 SERIES

8091	$ .53	8214	$1.49	8811	$ .59
8092	.53	8220	1.49	8812	.89
8095	1.25	8230	2.19	8822	2.19
8121	.80	8520	1.16	8830	2.19
8123	1.43	8551	1.39	8831	2.19
8130	1.97	8552	2.19	8836	.25
8200	2.33	8554	2.19	8880	1.19
8210	2.79	8810	.69	8263	5.79
				8267	2.59

9000 SERIES

9002	$ .35	9309	$ .79	9601	$ .89
9301	1.03	9312	.79	9602	.79

Data sheets supplied on request
Add $.50 ea. for items less than $1.00

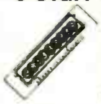
CMOS

4000A	$ .39	4019A	$ .69	4066A	$1.19
4001A	.39	4020A	1.98	4068A	.49
4002A	.39	4021A	1.89	4069A	.49
4006A	1.95	4023A	.39	4071A	.40
4007A	.40	4024A	1.45	4072A	.40
4008A	1.98	4025A	.39	4073A	.40
4009A	.69	4027A	.98	4075A	.40
4010A	.69	4028A	1.69	4078A	.40
4011A	.39	4030A	.79	4081A	.40
4013A	.69	4035A	1.89	4082A	.40
4014A	1.98	4042A	1.89	4528A	1.60
4015A	1.98	4049A	.79	4585A	2.40
4016A	.69	4050A	.79	4047A	2.75
74C00	$ .22	74C74	$1.04	74C162	$2.93
74C02	.26	74C76	1.34	74C163	2.66
74C04	.44	74C107	1.13	74C164	2.66
74C08	.68	74C151	2.61	74C173	2.61
74C10	.35	74C154	3.15	74C195	2.66
74C20	.35	74C157	1.76	80C95	1.35
74C42	1.61	74C160	2.48	80C97	1.13
74C73	1.04	74C161	2.93		

5203
2048 bit programmable ROM UV erasable **$14.95**

MAN3M LED DISPLAY
RH dec comm cathode .12" character **12 for $1.98**

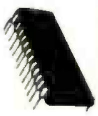
9 DIGIT LED DISPLAY



On multiplexed substrate, comm. cathode compatable with all 8 digit calculator chips. 7 segment right hand decimal, red with clear magnifying lens. .12" character, 1 to 4 MA, 1.8 V typ 2⅜" x ¼" x 1/16" high $3.95

CLOSEOUT ON CALCULATOR CHIPS

These early model calculator chips have been superseded and are now offered at this lowest price ever. Complete with data.



CT5001 12 digit display and calculate, 4 function, chain operation, fixed dec. 40 pin package **$1.95**
CT5002 Same as 5001 except battery operation **$2.95**
CT5005 12 digit display and calculate, 4 function plus memory. 28 pin package **$3.49**

WITH PURCHASE OF ANY OF THE ABOVE —

MAN 3M led display, RH common cathode, 12" character **12 for $1.79**

AUGUST SPECIALS

DIGITAL CIRCUITS (DIP PKG)

7448	BCD - 7 seg Decoder/Driver (30V)	$ .89
7474	Dual D flip-flop	.29
74107	Dual J-K flip-flop	.33
74123	Retrig monostable multivib w/clr	.69

LINEAR CIRCUITS (DIP PKG)

380	2 watt audio amplifier	$1.09
3900	Quad amplifier	.29

POCKET CALCULATOR KIT

5 function plus constant — addressable memory with individual recall — 8 digit display plus overflow — battery saver — uses standard or rechargeable batteries — all necessary parts in ready to assemble form — instructions included.

CALC KIT	$12.95
ASSEMBLED	14.95
SET OF ALKALINE BATT.	2.00

OUR 10% DISCOUNT HAS BEEN DEDUCTED FROM ALL PRICES REGARDLESS OF AMOUNT OF ORDER.

MEMORIES

1101	256 bit RAM MOS	$ 1.50
1103	1024 bit RAM MOS	3.95
2102	1024 bit static RAM	5.55
5203	2048 bit UV eras PROM	17.95
5260	1024 bit RAM	2.49
5261	1024 bit RAM	2.69
5262	2048 bit RAM	5.95
7489	64 bit ROM TTL	2.48
8223	Programmable ROM	1.69
74200	256 bit RAM tri-state	5.90

CALCULATOR & CLOCK CHIPS

5001	12 DIG 4 funct fix dec	$3.45
5002	Same as 5001 exc btry pwr	3.95
5005	12 DIG 4 funct w/mem	4.95
MM5725	8 DIG 4 funct chain & dec	1.98
MM5736	18 pin 6 DIG 4 funct	4.45
MM5738	8 DIG 5 funct K & Mem	5.35
MM5739	9 DIG 4 funct (btry sur)	5.35
MM5311	28 pin BCD 6 dig mux	4.45
MM5312	24 pin 1 pps BCD 4 dig mux	3.95
MM5313	28 pin 1 pps BCD 6 dig mux	4.45
MM5314	24 pin 6 dig mux	4.45
MM5316	40 pin alarm 4 dig	5.39

LED's

MV108	Red TO 18	$ .22
MV50	Axial leads	.18
MV5020	Jumbo Vis. Red (Red Dome)	.22
	Jumbo Vis. Red (Clear Dome)	.22
ME4	Infra red diff. dome	.54
MAN1	Red 7 seg. .270"	2.19
MAN2	Red alpha num .32"	4.39
MAN4	Red 7 seg. .190"	1.95
MAN5	Green 7 seg. .270"	3.45
MAN6	.6" high solid seg.	4.25
MAN7	Red 7 seg. .270"	1.19
MAN8	Yellow 7 seg. .270"	3.45
MAN64	.4" high solid seg.	2.95
MAN66	.6" high spaced seg.	3.75
MCT2	Opto-iso transistor	.61

SHIFT REGISTERS

MM 5013	1024 bit accum. dynamic	mDIP	$1.75
MM 5016	500/512 bit dynamic	mDIP	1.59
MM 5058	1024 bit static	DIP	3.45
SL 5-4025	Dual 64 bit static	DIP	1.39

DTL

930	$ .15	937	$ .15	949	$ .15
932	.15	944	.15	962	.15
936	.15	946	.15	963	.15

LINEAR CIRCUITS

300	Pos V Reg (super 723)	TO-5	$ .71
301	Hi Perf Op Amp	mDIP TO-5	.29
302	Volt follower	TO-5	.53
304	Neg V Reg	TO-5	.80
305	Pos V Reg	TO-5	.71
307	Op AMP (super 741)	mDIP TO-5	.26
308	Micro Pwr Op Amp	mDIP TO-5	.89
309K	5V 1A regulator	TO-3	1.35
310	V Follower Op Amp	TO-5 mDIP	1.07
311	Hi perf V Comp	mDIP TO-5	.95
319	Hi Speed Dual Comp	DIP	1.13
320	Neg Reg 5.2, 12, 15	TO-3	1.04
322	Precision Timer	DIP	1.70
324	Quad Op Amp	DIP	1.52
339	Quad Comparator	DIP	1.58
340T	Pos Volt Reg (5V-6V		1.79
	8V-12V-15V-18V-24V)	TO-220	1.04
370	AGC/Squelch AMPL	TO-5 or DIP	.71
372	AF-IF Strip detector	DIP	2.93
373	AM/FM/SSB Strip	DIP	.53
376	Pos. V. Reg	mDIP	2.42
377	2w Stereo amp	DIP	1.16
380	2w Audio Amp	DIP	1.13
380-8	.6w Audio Amp	mDIP	1.52
381	Lo Noise Dual preamp	DIP	1.52
382	Lo Noise Dual preamp	DIP	.71
550	Prec V Reg	DIP	.89
555	Timer	mDIP	.89
556A	Dual 555 Timer	DIP	1.49
560	Phase Locked Loop	DIP	2.48
562	Phase Locked Loop	DIP	2.48
565	Phase Locked Loop	DIP TO-5	2.38
566	Function Gen	mDIP TO-5	2.25
567	Tone Decoder	mDIP	2.66
709	Operational AMPL	TO-5 or DIP	.26
710	Hi Speed Volt Comp	DIP	.35
711	Dual Difference Compar	DIP	.26
723	V Reg	DIP	.62
739	Dual Hi Perf Op Amp	DIP	1.07
741	Comp Op AMP	mDIP TO-5	.32
747	Dual 741 Op Amp	DIP or TO-5	.71
748	Freq Adj 741	mDIP	.35
1304	FM Mulpx Stereo Demod	DIP	1.07
1307	FM Mulpx Stereo Demod	DIP	.74
1458	Dual Comp Op Amp	mDIP	.62
1800	Stereo multiplexer	DIP	2.48
LH2111	Dual LM 211 V Comp	DIP	1.70
3065	TV-FM Sound System	DIP	
3075	FM Det-LMTR &		.62
	Audio preamp	DIP	.71
3900	Quad Amplifier	DIP	.35
7524	Core Mem Sense AMPL	DIP	.71
7534	Core Mem Sense Amp	DIP	.71
8864	9 DIG Led Cath Drvr	DIP	2.25
75150	Dual Line Driver	DIP	1.95
75451	Dual Perepheral Driver	mDIP	.35
75452	Dual Peripheral Driver	mDIP	.35
75453	(351) Dual Periph. Driver	mDIP	.35
75491	Quad Seq Driver for LED	DIP	.71
75492	Hex Digit Driver	DIP	.80

Satisfaction guaranteed. Shipment will be made via first class mail within 3 days from receipt of order. Add $.50 to cover shipping and handling for orders under $25.00. Minimum order $5.00. California residents add sales tax.

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P.O. BOX 1708/ MONTEREY, CA. 93940 USA
PHONE (408) 659-3171

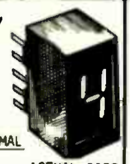
2102-2 MOS 1024 BIT MEMORY

FULLY DECODED STATIC RANDOM ACCESS MEMORY
DIRECTLY TTL COMPATIBLE INPUTS AND OUTPUT
SINGLE 5V SUPPLY - - NO CLOCKS OR REFRESH

NEW

$6.95 EA. (DIP) 8 FOR $49.95

Numeric Display ¼" Single Digit GaAsP LED



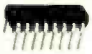
COMMON CATHODE WITH RH DECIMAL

ACTUAL SIZE

Compact—10 digits in 3" panel width
Highly legible— bright red 1/4" character easily read within 10 feet over a wide viewing angle
125 mW per digit at typical brightness

SUPER SPECIAL $.75
TEN for $5.95

SPECIAL 8223 PROM

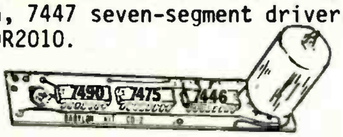


8 BIT
32 WORD
MEMORY
$3.00 EA.
10 - $29

WE PROGRAM FOR $5 EACH

CD-2 COUNTER KIT

Unit includes board, 7490, 7475, quad latch, 7447 seven-segment driver, and RCA DR2010.



COMPLETE KIT only $11.95; FULLY-ASSEMBLED $15.00; boards can be supplied separately at $2.50 per digit.

RCA 2010

Numitron Digital Display Tube, incandescent 5-volt 7-segment:
.6" High numeral visible from 30 ft
Standard 9-pin base (solderable)
Left-hand decimal point
EACH $5.00 5 FOR $20.00

CMOS

CD4000	$.55	CD4016	1.00
CD4001	.45	CD4019	1.00
CD4002	.45	CD4023	.45
CD4007	1.00	CD4024	1.60
CD4008	3.25	CD4025	.45
CD4009	.75	CD4027	1.00
CD4010	.75	CD4030	1.00
CD4011	.45	74C20	.65
CD4012	.45	74C42	2.00
CD4013	1.00	74C157	2.50
CD4015	3.00	74C161	3.00
		74C195	2.00

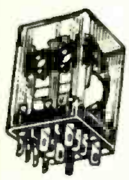
TRANSISTOR SPECIAL

2N3568-HEP736
TO92 PLASTIC
NPN 300MW
60V 40-120B

EACH	$.15
TEN	1.00
100	9.00
1000	80.00

NEW-TELEDYNE MARKED T3568

POTTER BRUMFIELD



Type KHP Relay
4 PDT 3A Contacts
24 VDC (650 coil) $1.50 EA.
120 VAC (10.5 MA coil) $1.75 EA.

TTL DIP

7400	.20
74H00	.25
7401	.20
74H01	.25
7402	.25
7403	.25
7404	.25
74H04	.30
7405	.30
7406	.40
7408	.30
7400	.20
7410	.20
7413	.75
7417	.40
7420	.20
74L20	.30
74H20	.30
74H22	.30
7430	.20
74H30	.30
74L30	.30
7440	.20
74H40	.30
7442	1.00
7447	1.50
7450	.20
74H50	.30
7451	.20
74H51	.25
7453	.20
7454	.20
74L54	.25
74L55	.25
7460	.16
74L71	.25
7472	.40
74L72	.60
7473	.35
74L73	.75
7474	.45
74H74	.75
7475	.80
7476	.55
74L78	.70
7480	.50
7483	.70
7489	3.00
7490	1.00
7492	.65
7493	1.00
7495	.65
74L95	1.00
74107	.50
74145	1.25
74180	1.00
74193	1.50
74195	.80

SEND FOR FREE FLYER!

C.O.D. PHONE ORDERS ACCEPTED--$10 MINIMUM

All IC's new and fully tested, leads plated with gold or solder. Orders for $5.00 or more are shipped prepaid, smaller orders--add 55¢. California residents add Sales Tax......IC's shipped within 24 hours.

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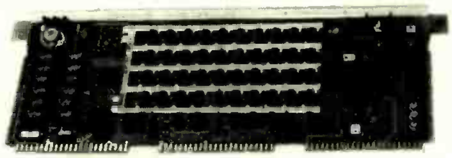
Circle 92 on reader service card

FANTASTIC BOARD SET

This unusual set of 5 boards contains a wide variety of late parts, including the following: 3reed relays, including a latching relay, over 90 small signal diodes, over 30 rectifier diodes, 11 2N5061 SCRs,many transistors including 2N6027, 2N6028, 2N4401, 2N5088, 2N3903, 2N3905. 2 bridge rectifiers, 46 Teledyne HiNIL high noise immunity integrated circuits.G.E. SCRs, and TI power transistors, plus many capacitors, etc.
STOCK NO.R5277 set of 5 boards $6.00 10/11.00

ANOTHER GIANT SOPHISTICATED BOARD



Super board has 13 reed relays, designed for 12 or 24 volts. 1 SPDT reed relay, LM-309 regulator, 49 TTL & DTL ICs, 2 TO-5 linear ICs, 11 2N5061 SCRs, transistors, diodes, capacitors and much more. We supply data on most of the parts. 7"x18½"
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Circle 93 on reader service card

LOOK FOR THE SEPT. ISSUE OF RADIO-ELECTRONICS AT YOUR NEWSDEALER AUG. 19

CAVE grafix

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FINE PRINT: ALL ENTRIES MUST BE POSTMARKED BY AUG 31 AND BE IN OUR HANDS BY SEP 7, 1975; ENTRIES BECOME PROPERTY OF BILL GODBOUT ELECTRONICS. ALL CONTESTANTS RECEIVE A DATA SHEET ABOUT OUR FIRST PRIZE. WINNER WILL BE NOTIFIED BY OCT 1, 1975. IF YOU DON'T WIN ANYTHING THIS TIME AROUND, DON'T FEEL TOO BAD; ENTER OUR COMING CONTEST FOR A COMPLETE 16 BIT MICROCOMPUTER KIT. THESE CONTESTS SPOTLIGHT PRODUCTS WE'RE INTRODUCING FOR FALL '75. SEND ENTRIES TO "16 BIT CONTEST", BOX 2355, OAKLAND AIRPORT, CALIFORNIA 94614.

March ad error: memory board from Solid State Music

Circle 96 on reader service card

PLESSEY SEMICONDUCTORS

LINEAR INTEGRATED CIRCUITS

Type	Description	1-24	25-99	100 up
GENERAL PURPOSE AMPLIFIERS				
SL201B	GP amplifier	4.01	3.51	3.01
SL201C	GP amplifier	1.87	1.64	1.40
MATCHED NPN TRANSISTORS				
SL301A	Matched pair	2.72	2.46	1.40
SL301B	Matched pair	2.30	2.01	1.72
SL303A	Matched triplet	5.47	4.78	4.09
SL303B	Matched triplet	3.93	3.43	2.93
SL305B	Dual matched pairs	7.37	6.44	5.52
SL312B	Matched pair w/tail	2.85	2.56	2.27
SL354B	Matched quad	4.22	3.70	3.17
SL360C	2.5GHz matched pr.	10.93	9.56	8.18
SL362C	2.5GHz low noise pr.	16.26	14.20	12.14
SL3045C	Transistor array	2.77	2.43	2.09
SL3145C	2.5GHz trans. array	14.78	12.94	11.09
AUDIO CIRCUITS				
SL414A	3W audio amplifier	4.22	3.70	3.17
SL415A	5W audio amplifier	5.49	4.81	4.12
POWER CONTROL CIRCUITS				
SL440	Power control circuit	5.49	4.81	4.12
TRANSISTOR ARRAYS				
SL3046	Five-transistor array	1.85	1.61	1.37
LINEAR RF AMPLIFIERS				
SL501A	RF amplifier	19.25	16.84	14.44
SL501B	RF amplifier	5.91	5.17	4.44
SL502A	RF amplifier	14.55	13.04	11.54
SL502B	RF amplifier	3.88	3.49	3.09
SL503A	RF amplifier	16.50	14.78	13.07
SL503B	RF amplifier	4.12	3.70	3.27
SL551A	RF amplifier	18.82	16.87	14.92
SL551B	RF amplifier	5.89	5.28	4.67
SL552A	RF amplifier	18.82	16.87	14.92
SL552B	RF amplifier	5.89	5.28	4.67
SL553A	RF amplifier	21.09	18.90	16.71
SL553B	RF amplifier	6.28	5.62	4.96
SL510C	RF det.& video amp.	25.34	22.18	19.00
SL511C	RF det.& video amp.	25.34	22.18	19.00
LIMITING WIDEBAND AMPLIFIERS				
SL521A	Limiting RF amp.	27.72	24.26	20.80
SL521B	Limiting RF amp.	17.58	15.58	13.57
SL521C	Limiting RF amp.	10.59	9.27	7.95
SL571A	Limiting RF amp.	37.80	33.08	28.35
SL571B	Limiting RF amp.	23.39	20.46	17.53
SL571C	Limiting RF amp.	17.48	15.29	13.09
SL525C	Wideband amplifier	5.80	5.20	4.60
SL530C	Logarithmic amp.	17.58	15.58	13.57
SL550C	200MHz widebd amp	26.19	21.81	18.16
SL1030C	200MHz widebd amp	29.57	25.87	22.18
RADIO COMMUNICATIONS CIRCUITS				
SL610C	RF amplifier	4.07	3.56	3.06
SL611C	RF amplifier	4.07	3.56	3.06
SL612C	IF amplifier	4.07	3.56	3.06
SL613C	Limiting amp/det.	8.66	7.58	6.49
SL620C	VOGAD	6.15	5.39	4.62
SL621C	AGC generator	6.15	5.39	4.62
SL622C	AF amp/VOGAD sidetone amplifier	15.21	13.31	11.41
SL623C	AM det./AGC amp/ SSB demod.	11.19	9.79	8.40
SL624C	Multimode det. AF amp	5.70	5.00	4.28
SL630C	AF amplifier	3.85	3.38	2.90
SL640C	Dbl. bal. modulator	7.55	6.60	5.65
SL641C	Receiver mixer	7.55	6.60	5.65
SL645C	Square law device	7.55	6.60	5.65
SL650B	Mod./phase loc. loop	10.86	9.31	7.76
SL650C	Mod./phase loc. loop	6.80	5.83	4.86
SL651B	Mod./phase loc. loop	12.06	10.34	8.62
SL651C	Mod./phase loc. loop	7.56	6.84	5.40
OPERATIONAL AMPLIFIERS				
SL701B	Op. amplifier	7.13	6.23	5.39
SL701C	Op. amplifier	3.56	3.12	2.67
SL702B	Op. amplifier	7.13	6.23	5.39
SL702C	Op. amplifier	3.56	3.12	2.67
SL717A	Dual comparator	10.35	9.06	7.76
SL717C	Dual comparator	6.67	5.76	4.94
SL751B	Op. amplifier	8.37	7.50	6.63
SL751C	Op. amplifier	4.81	4.30	3.80
TELECOMMUNICATIONS CIRCUIT				
SL1001A	Linear mod/demod.	3.22	2.83	2.43
SL1001B	Linear mod/demod.	3.22	2.83	2.43
SL1020A	Lin. amp. remote DC control	7.15	6.26	5.36
TELEVISION CIRCUITS				
SAA570	Limit. IF amp/FM det.	4.22	4.22	3.30
SAA661	Limit. IF amp/FM det.	4.73	4.73	3.70
SAA700	Signal processor	10.14	10.14	7.92
SBA550	Signal processor	10.14	10.14	7.92
SBA750	Limit. IF amp/FM det.	4.73	4.73	3.70
SL432	Limit. IF amp/FM det.	4.73	4.73	3.70
SL437C	IF & AGC for PNP tuners	13.52	13.52	10.56
SL437D	IF & AGC for NPN tuners	13.52	13.52	10.56
SL442	Switch mode power supply control	9.24	7.92	6.60
SL450	Power sup. & Syn. sep.	11.09	9.50	7.92
SL456A	TV IF system	7.39	6.34	5.28
SL456B	TV IF system	7.39	6.34	5.28
SL457A	TV IF system	7.39	6.34	5.28
SL457B	TV IF system	7.39	6.34	5.28
SL901	Color demodulator	10.14	10.14	7.92
SL917	Color decoder	13.52	13.52	10.56

DIGITAL INTEGRATED CIRCUITS

Type	Description	1-24	25-99	100 up
PROCESS CONTROL CIRCUITS				
SP520	Gray code counter	13.94	12.49	11.04
SP521	Binary rate multip.	13.94	12.49	11.04
SP522	Phase loc.div.& com.	13.94	12.49	11.04
PECL II – SP1000 SERIES				
SP1004B	Dual 4 I/P OR/NOR gate	1.71	1.48	1.25
SP1005B	Dual 4 I/P OR/NOR gate	1.71	1.48	1.25
SP1006B	Dual 4 I/P OR/NOR gate	1.71	1.48	1.25
SP1007B	Triple 3 I/P NOR gate	1.71	1.48	1.25
SP1008B	Triple 3 I/P NOR gate	1.71	1.48	1.25
SP1009B	Triple 3 I/P NOR gate	1.71	1.48	1.25
SP1010B	Quad 2 I/P NOR gate	1.71	1.48	1.25
SP1011B	Quad 2 I/P NOR gate	1.71	1.48	1.25
SP1012B	Quad 2 I/P NOR gate	1.71	1.48	1.25
SP1023B	Dual 4 I/P clock driv.	2.80	2.40	2.00
SP1039B	PECL to sat. logic trans.	6.07	5.20	4.33
SP1204B	Dual 4 I/P OR/NOR gate	2.17	1.86	1.55
SP1205B	Dual 4 I/P OR/NOR gate	2.17	1.86	1.55
SP1206B	Dual 4 I/P OR/NOR gate	2.17	1.86	1.55
SP1207B	Triple 3 I/P NOR gate	2.17	1.86	1.55
SP1208B	Triple 3 I/P NOR gate	2.17	1.66	1.55
SP1209B	Triple 3 I/P NOR gate	2.17	1.86	1.55
SP1211B	Quad 2 I/P NOR gate	2.17	1.86	1.55
SP1223B	Quad 4 I/P clock driv.	3.50	3.00	2.50
SP1239B	PECL to sat. logic trans.	7.60	6.51	5.42
PECL III – SP1600 SERIES				
SP1660B	Dual 4 I/P gate HI-Z	15.00	12.00	10.00
SP1662B	Quad 2 I/P NOR gate Hi-Z	16.50	13.20	11.00
SP1664B	Quad 2 I/P OR gate HI-Z	16.50	13.20	11.00
SP1670B	Single D F/F HI-Z	27.00	21.60	18.00
SP8000 SERIES HIGH SPEED DIVIDERS				
SP8600A	÷ 4 at 250MHz	25.20	21.60	18.00
SP8600B	÷ 4 at 250MHz	11.06	9.48	7.90
SP8601A	÷ 4 at 150MHz	15.96	13.68	11.40
SP8601B	÷ 4 at 150MHz	10.08	8.64	7.20
SP8602A	÷ 2 at 500MHz	95.00	81.43	67.86
SP8602B	÷ 2 at 500MHz	26.82	22.99	19.16
SP8603A	÷ 2 at 400MHz	71.68	61.44	51.20
SP8603B	÷ 2 at 400MHz	20.29	13.39	14.49
SP8604A	÷ 2 at 300MHz	34.58	29.64	24.70
SP8604B	÷ 2 at 300MHz	15.40	13.20	11.00
SP8607B	÷ 2 at 600MHz	40.99	35.14	29.28
SP8613B	÷ 4 at 700MHz	49.00	42.00	35.00
SP8614B	÷ 4 at 800MHz	56.00	48.00	40.00
SP8615B	÷ 4 at 900MHz	67.20	57.60	48.00
SP8616B	÷ 4 at 1GHz	81.20	69.60	58.00
SP8616D	÷ 4 at 950MHz	74.20	63.60	53.00
SP8620B	÷ 5 at 400MHz	45.92	39.36	32.80
SP8621B	÷ 5 at 300MHz	31.78	27.24	22.70
SP8622B	÷ 5 at 200MHz	25.13	21.54	17.95
SP8630B	÷ 10 at 600MHz	69.82	59.84	49.87
SP8630D	÷ 10 at 550MHz	58.80	50.40	42.00
SP8631B	÷ 10 at 500MHz	53.20	45.60	38.00
SP8632B	÷ 10 at 400MHz	42.00	36.00	30.00
SP8634B	÷ 10 (BCD) at 700MHz	81.20	69.60	58.00
SP8635B	÷ 10 (BCD) at 600MHz	70.00	60.00	50.00
SP8636B	÷ 10 (BCD) at 500MHz	60.20	51.60	43.00
SP8637B	÷ 10 (BCD) at 400MHz	50.40	43.20	36.00
SP8640A	÷ 10/11 (ECL) at 200MHz	28.00	24.00	20.00
SP8640B	÷ 10/11 (ECL) at 200MHz	12.99	11.14	9.28
SP8641A	÷ 10/11 (ECL) at 250MHz	32.20	27.60	23.00
SP8641B	÷ 10/11 (ECL) at 250MHz	19.04	16.32	13.60
SP8642A	÷ 10/11 (ECL) at 300MHz	58.80	50.40	42.00
SP8642B	÷ 10/11 (ECL) at 300MHz	25.20	21.60	18.00
SP8643B	÷ 10/11 (ECL) at 350MHz	35.00	30.00	25.00
SP8650B	÷ 16 at 600MHz	70.00	60.00	50.00
SP8651B	÷ 16 at 500MHz	53.20	45.60	38.00
SP8652B	÷ 16 at 400MHz	42.00	36.00	30.00
SP8655A	÷ 32 at 100MHz	63.00	54.00	45.00
SP8655B	÷ 32 at 100MHz	21.00	18.00	15.00
SP8657A	÷ 20 at 100MHz	63.00	54.00	45.00
SP8657B	÷ 20 at 100MHz	21.00	18.00	15.00
SP8659A	÷ 16 at 100MHz	53.20	45.60	38.00
SP8659B	÷ 16 at 100MHz	18.90	16.20	13.50
SP8665B	÷ 10 at 1.0GHz	98.00	84.00	70.00
SP8666B	÷ 10 at 1.1GHz	107.80	92.40	77.00
SP8667B	÷ 10 at 1.2GHz	119.00	102.00	85.00
SP8670B	÷ 8 at 600MHz	63.00	54.00	45.00
SP8671B	÷ 8 at 500MHz	49.00	42.00	35.00
SP8672B	÷ 8 at 400MHz	37.80	32.40	27.00
SP8685A	÷ 10/11 at 500MHz	116.20	99.60	83.00
SP8685B	÷ 10/11 at 500MHz	35.00	30.00	25.00
SP8690A	÷ 10/11 at 100MHz	63.00	54.00	45.00
SP8690B	÷ 10/11 at 100MHz	19.60	16.80	14.00
MNOS NON-VOLATILE MEMORY ELEMENTS				
NOM201C	Single MNOS trans.	4.44	3.80	3.17
NOM202C	MNOS transistor pr.	7.39	6.34	5.28
NOM204C	Quad MNOS trans.	12.94	11.09	9.24
NOM401C	8x8 MNOS array	33.26	28.51	23.76
INTERFACE CIRCUITS				
SP701A	MOS analog switch driv.	14.15	12.38	10.61
SP701B	MOS analog switch driv.	10.56	9.24	7.92
SP702A	MOS logic driver	14.15	12.38	10.61
SP702B	MOS logic driver	10.56	9.24	7.92
SP703A	MOS logic & clock driv.	14.15	12.38	10.61
SP703A*	MOS logic & clock driv.	18.32	16.03	13.73
SP703B	MOS logic & clock driv.	10.56	9.24	7.92
SP703B*	MOS logic & clock driv.	14.78	12.94	11.09
SP704A	MOS logic & clock driv.	14.15	12.38	10.61
SP704A*	MOS logic & clock driv.	18.32	16.03	13.73
SP704B	MOS logic & clock driv.	10.56	9.24	7.92
SP704B*	MOS logic & clock driv.	14.78	12.94	11.09
SP721B	Balanced line driver	8.26	7.23	6.20
SP721B*	Balanced line driver	12.67	11.09	9.50
SP722B	TTL driver	8.26	7.23	6.20
SP722B*	TTL driver	12.67	11.09	9.50
SP723B	TTL driver	9.40	8.24	7.05
SP723B*	TTL driver	13.73	12.01	10.30
SP724B	Dual TTL driver	11.83	10.35	8.87
SP724B*	Dual TTL driver	16.47	14.41	12.36
SP740B	Current comparator	30.41	26.61	22.81
SP740B*	Current comparator	37.83	33.11	28.38
SP741B	Current comparator	30.41	26.61	22.81
SP741B*	Current comparator	37.83	33.11	28.38
SP751A	MOS analog switch driv.	18.32	16.03	13.73
SP751B	MOS analog switch driv.	14.78	12.94	11.09

* FLAT PACK

EXAR ICs

Type	Description	1-9	10 up	100 up
XR-100K	XR-chip cust. IC des. kit	$80.00	$80.00	$80.00
XR-B101	NPN trans. array, sm. sig.	3.50	3.50	3.50
XR-B102	PNP array	3.50	3.50	3.50
XR-C101	NPN array, sm. sig.	3.50	3.50	3.50
XR-C102	PNP array, lat. & subs.	3.50	3.50	3.50
XR-C103	NPN array, pwr.& schottky	3.50	3.50	3.50
XR-C104	Diffused resistor array	3.50	3.50	3.50
XR-C105	Diffused & pinch resis. array	3.50	3.50	3.50
XR-C106	Bal. mod.& NPN,PNP cur. source	3.50	3.50	3.50
XR-S200	Multi-function IC	28.00	23.00	21.00
XR-205	Waveform gen. IC	8.40	7.35	6.30
XR-205K	Waveform gen. kit	25.00	25.00	25.00
XR-210	FSK mod. demod.	5.20	4.55	3.90
XR-210M	FSK mod. demod.	10.40	9.10	7.80
XR-215	Gen. Purpose PLL	6.56	5.74	4.92
XR-320	Timing circuit	1.52	1.33	1.14
XR-555CP	Timing circuit	1.07	.94	.80
XR-556M	Dual timing circuit	10.56	9.24	7.92
XR-555CN	Dual timing circuit	2.88	2.52	2.16
XR-556CP	Dual timing circuit	1.82	1.60	1.37
XR-567M	Tone decoder	12.96	11.34	9.72
XR-567CN	Tone decoder	1.84	1.61	1.38
XR-567CP	Tone decoder	1.68	1.47	1.26
XR-1310P	Stereo demod.	3.20	2.80	2.40
XR-1310EP	Stereo demod.	3.20	2.80	2.40
XR-1468CN	±5V tracking VR	3.84	3.36	2.88
XR-1468CP	±5V tracking VR	2.54	2.23	1.91
XR-1488N	Quad line driver	5.76	5.04	4.32
XR-1488P	Quad line driver	5.20	4.55	3.90
XR-1489AN	Quad line rec.	4.80	4.20	3.60
XR-1489AP	Quad line rec.	4.32	3.78	3.24
XR-1568M	±15V track. VR	14.32	12.53	10.74
XR-1568N	±15V track. VR	7.20	6.30	5.40
XR-1800P	Stereo decoder	3.20	2.80	2.40
XR-2206N	Monolithic funct. gen.	$11.20	9.80	8.40
XR-2206P	Monolithic funct. gen.	10.24	8.96	7.68
XR-2206CN	Monolithic funct. gen.	6.16	5.39	4.62
XR-2206CP	Monolithic funct. gen.	5.12	4.48	3.84
XR-2207M	VCO	15.44	13.51	11.58
XR-2207N	VCO	7.76	5.79	5.82
XR-2207P	VCO	6.72	5.88	5.04
XR-2207CN	VCO	4.80	4.20	3.60
XR-2207CP	VCO	3.84	3.36	2.88
XR-2208M	Op. multiplier	17.76	15.54	13.32
XR-2208N	Op. multiplier	8.88	7.77	6.66
XR-2208P	Op. multiplier	7.92	6.93	5.94
XR-2208CN	Op. multiplier	5.60	4.90	4.20
XR-2208CP	Op. multiplier	5.20	4.55	3.90
XR-2211CN	FSK demod./tone decoder	7.57	6.62	5.68
XR-2211CP	FSK demod./tone decoder	6.88	6.02	5.16
XR-2240M	Prog. timer/ctr.	19.52	17.08	14.64
XR-2240N	Prog. timer/ctr.	8.80	7.70	6.60
XR-2240P	Prog. timer/ctr.	7.20	6.30	5.40
XR-2240CN	Prog. timer/ctr.	6.24	5.46	4.68
XR-2240CP	Prog. timer/ctr.	4.80	4.20	3.60
XR-2556M	Dual 555 timer	10.56	9.24	7.92
XR-2556CN	Dual 555 timer	3.52	3.08	2.64
XR-2556CP	Dual 555 timer	3.20	2.80	2.40
XR-2567M	Dual 567 tone decoder	16.94	14.83	12.71
XR-2567CN	Dual 567 tone decoder	7.90	6.92	5.93
XR-2567CP	Dual 567 tone decoder	5.18	4.54	3.89

The Function Generator Kit features sine, triangle and square wave, THD 0.5% typ., AM/FM capability.

XR-2206KA FUNCTION GENERATOR KIT $18.95
Includes monolithic function generator IC, PC board, and assembly instruction manual.

XR-2206KB FUNCTION GENERATOR KIT $28.95
Same as XR-2206KA above and includes external components for PC board.

STANDARD MICROSYSTEMS

Type	Description	1-9	10 up	100 up
COM2502	Universal asynchronous receiver transmitter	$13.20	$10.60	$ 8.80
COM2502P		8.00	6.85	5.95
COM2017		13.20	10.60	8.80
COM2017P		8.00	6.85	5.95
COM2502H		25.00	20.00	16.00
COM2017H		25.00	20.00	16.00
COM2601	Univ. sync. rec./trans.	30.00	24.00	20.50
COM5016	Dual baud rate gen. prog. div.	12.00	9.60	8.00
	Keyboard encoder ROM			
KR2376-ST	Keyboard encoder ROM	20.00	17.50	15.00
KR3600-ST	10-channel multiplexer	20.00	17.50	15.00
NMX5010	10-channel multiplexer	12.00	9.60	8.00
CAL1022	12-digit print. cal. sgl. chip MOS/LSI circuit	60.00	52.00	45.00

ELECTRONIC ARRAYS

1024 BIT READ/WRITE RANDOM ACCESS MEMORY
N-CHANNEL, SILICON GATE

	1-24	25 up	100 up
EA 1500AJ	$21.00	$16.80	$14.00
EA 1500ASJ	16.00	14.40	12.00

PREMIUM QUALITY TRANSISTORS

Type	Price	Type	Price	Type	Price	Type	Price
2N173	2.15	2N877	2.50	2N1921	3.00	2N2600	7.10
2N178	1.00	2N894	2.00	2N1924	1.30	2N2604	1.80
2N293	.60	2N918	.40	2N1934	9.40	2N2605	.50
2N293B	.65	2N956	.40	2N1990	.80	2N2646	.70
2N321	.50	2N960	.50	2N2060	2.10	2N2648	4.00
2N327A	1.40	2N962	.50	2N2065A	1.80	2N2658	7.00
2N334	1.40	2N967	.50	2N2080	5.00	2N2708	.25
2N336	1.00	2N981	2.00	2N2081A	2.50	2N2712	.30
2N338A	1.25	2N984	1.00	2N2100	3.00	2N2713	.15
2N389	9.00	2N1015B	16.00	2N2102	.50	2N2715	.18
2N393	2.70	2N1016B	18.00	2N2148	.70	2N2716	.18
2N398B	1.00	2N1026	1.50	2N2192A	.66	2N2784	95.00
2N404	.20	2N1035	2.00	2N2193	.45	2N2802	9.80
2N417	.80	2N1136	1.50	2N2193A	.90	2N2808	9.00
2N420	1.20	2N1137A	2.00	2N2218	.26	2N2833	4.00
2N424	9.00	2N1142	2.20	2N2218A	.30	2N2880	11.00
2N439	1.00	2N1143	2.00	2N2219	.30	2N2890	4.60
2N443	1.15	2N1168	.75	2N2219A	.38	2N2892	6.70
2N456	1.30	2N1204	1.50	2N2221	.25	2N2893	9.80
2N497	1.40	2N1234	15.00	2N2221A	.26	2N2894	.50
2N501A	4.00	2N1302	.30	2N2222	.24	2N2895	1.00
2N508A	.40	2N1305	.35	2N2222A	.30	2N2903	4.00
2N512B	2.90	2N1377	1.50	2N2259	1.10	2N2904	.30
2N555	.50	2N1404	.50	2N2270	.40	2N2904A	.36
2N586	1.00	2N1408	.60	2N2289	3.70	2N2905	.32
2N594	1.50	2N1420	.50	2N2290	6.00	2N2905A	.34
2N630	3.50	2N1483	1.20	2N2297	1.00	2N2906	.18
2N652A	1.00	2N1485	1.60	2N2322	1.80	2N2906A	.20
2N677C	6.50	2N1523	5.00	2N2323	1.90	2N2907	.20
2N681	2.00	2N1534	1.00	2N2324	2.40	2N2907A	.30
2N682	2.50	2N1540	1.10	2N2325	2.60	2N2913	.90
2N683	2.70	2N1543	3.50	2N2326	3.40	2N2914	1.40
2N685	3.40	2N1544	.90	2N2327	4.60	2N2916A	4.05
2N686	4.00	2N1549	1.35	2N2328	5.00	2N2925	.20
2N689	7.00	2N1551	4.00	2N2329	7.00	2N2926	.15
2N697	.25	2N1552	4.00	2N2356	6.00	2N2947	14.50
2N700	4.00	2N1554	2.00	2N2356A	7.00	2N2949	6.00
2N705	.60	2N1557	1.70	2N2359	16.00	2N2950	6.50
2N706	.20	2N1560	3.30	2N2368	.30	2N2969	31.00
2N706B	.40	2N1595	1.50	2N2369	.20		
2N711	.40	2N1596	1.60	2N2382	4.50		
2N711B	.60	2N1597	2.20	2N2440	3.50		
2N718A	.30	2N1598	2.00	2N2453	3.00		
2N720A	.50	2N1599	2.30	2N2465	7.50		
2N741	1.50	2N1605	.45	2N2475	.60		
2N744	.35	2N1613	.50	2N2476	.80		
2N759	1.00	2N1671	2.00	2N2484	.25		
2N759A	1.00	2N1693	15.00	2N2511	1.50		
2N760	.50	2N1711	.50	2N2518	6.00		
2N760A	.70	2N1715	.70	2N2526	4.50		
2N829	3.00	2N1720	5.00	2N2527	5.50		
2N834	.35	2N1899	69.00	2N2537	1.30		
2N859	5.00	2N1907	5.00	2N2538	2.50		

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2N3019	1.50	2N3502	1.40	2N3693	.21
2N3022	18.00	2N3503	1.60	2N3694	.22
2N3053	.35	2N3506	7.50	2N3702	.18
2N3054	.80	2N3544	4.00	2N3705	.25
2N3055	.95	2N3548	2.80	2N3707	.17
2N3060	3.00	2N3549	3.00	2N3710	.20
2N3066A	1.20	2N3553	1.80	2N3711	.18
2N3070	1.30	2N3563	.15	2N3725	.36
2N3107	.80	2N3564	.14	2N3730	1.50
2N3109	.75	2N3565	.18	2N3731	2.00
2N3117	1.00	2N3567	.19	2N3740	1.20
2N3130	5.00	2N3568	.30	2N3763	5.00
2N3133	.80	2N3569	.17	2N3771	2.00
2N3202	16.00	2N3584	1.80	2N3772	2.30
2N3209	.90	2N3599	38.00	2N3773	2.40
2N3227	2.40	2N3614	1.10	2N3789	3.00
2N3239	3.00	2N3616	1.25	2N3793	.25
2N3247	3.90	2N3617	2.50	2N3796	3.00
2N3250	.50	2N3634	8.00	2N3799	3.20
2N3371	4.00	2N3638	.18	2N3805	10.50
2N3375	5.50	2N3642	.19	2N3807	4.80
2N3390	.50	2N3643	.14	2N3819	.30
2N3393	.20	2N3645	.15	2N3823	.70
2N3398	.25	2N3646	.10	2N3843	.30
2N3442	2.20	2N3656	8.60	2N3856	.25
2N3445	5.00	2N3657	9.00	2N3865	7.00
2N3467	1.50	2N3680	6.00	2N3866	1.10
2N3468	1.90	2N3684	1.25	2N3903	.20
2N3500	4.00	2N3685A	1.50	2N3904	.22
2N3501	6.50	2N3692	.20	2N3905	.20

Type	Price	Type	Price	Type	Price	Type	Price
2N3906	.22	2N4303	.30	2N4890	.90	2N5407	29.00
2N3909	.80	2N4341	1.35	2N4898	1.10	2N5409	32.00
2N3924	3.50	2N4347	1.60	2N4905	2.00	2N5414	6.50
2N3926	4.80	2N4348	2.00	2N4922	1.00	2N5449	.25
2N3945	.90	2N4352	2.00	2N5016	12.80	2N5453	5.40
2N3954	5.00	2N4356	.30	2N5036	1.18	2N5457	.40
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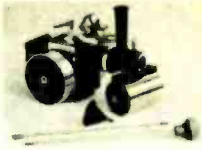

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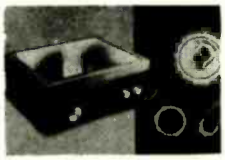

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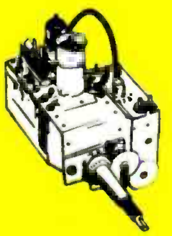
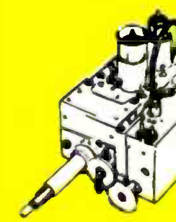
Originators of Complete TV Tuner Service

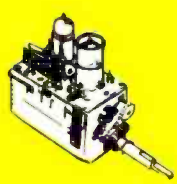
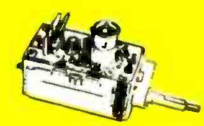
Castle offers the following services to solve ALL your television tuner problems.

Universal Replacements from $8.95

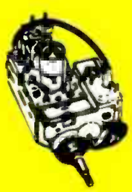
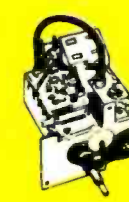
These universal replacement tuners are all equipped with memory fine tuning and uhf position with plug input for uhf tuner. They come complete with hardware and component kit to adapt for use in thousands of popular TV receivers.

STOCK No.	HEATERS	SHAFT Min.*	SHAFT Max.*	I.F. Snd.	PRICE
CR6P	Parallel 6.3v	1¾"	3"	41.25	8.95
CR7S	Series 600mA	1¾"	3"	41.25	9.50
CR9S	Series 450mA	1¾"	3"	41.25	9.50
CR6XL	Parallel 6.3v	2½"	12"	41.25	10.45
CR7XL	Series 600mA	2½"	12"	41.25	11.00
CR9XL	Series 450mA	2½"	12"	41.25	11.00

Castle Replacements $15.95

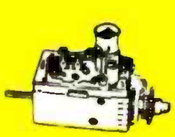
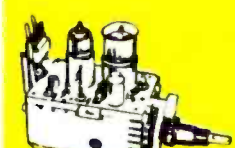
Castle custom replacements made to fit in place of original tuner. Purchase outright . . . no exchange needed. Write for current list of Castle replacements, or request the part number you require (use number on ORIGINAL TUNER ONLY; do not use service literature numbers). Available for many of the popular models of following manufacturers: Admiral, Curtis Mathes, Emerson, GE, Heathkit, Magnavox, Motorola, Muntz, Philco, RCA, Sears, Sylvania, Westinghouse, Zenith and many private labels.

Overhaul Service $9.95

This is the service pioneered by Castle! We are now in our third decade of serving the TV Service Industry

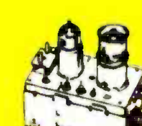
Service on all makes and models, vhf or uhf, including transistor and color tuners . . . one price $9.95 Overhaul includes parts, except tubes and transistors.

Remember! **Castle overhaul service is as near as your post office**

Simply send us the defective tuner complete; include tubes, shield cover and any damaged parts with model number and complaint. Your tuner will be expertly overhauled and returned promptly, performance restored, aligned to original standards and warranted for 90 days.

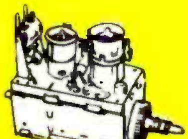
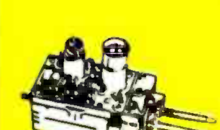
Dismantle tandem uhf and vhf tuners and send in defective unit only. Remove all accessories . . . or dismantling charge will apply.

Custom Exchange Service $17.95

When our inspection reveals that original tuner is unfit for overhaul, and it is not available from our stock of outright replacements, we offer to make a custom replacement on exchange basis. Charge for this service is $15.95 for uhf tuner and $17.95 for vhf tuner.

If custom replacement cannot be made we will custom rebuild the original tuner at the exchange replacement price.

All replacements are new or rebuilt. All prices are f.o.b. our plant. Add shipping and handling of $1.25 on all prepaid orders. We will ship C.O.D.


CASTLE TV TUNER SERVICE, INC.

5715 N. Western Ave., Chicago, Ill. 60645 • Ph. 312—561-6354

Circle 87 on reader service card