The how-to magazine of electronics...

AN INTERTEC PUBLICATION

ELECTRONIC™ Servicing & Technology

DECEMBER 1987/$2.25

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Tracking down remote control problems.

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Then there's the DM25L. Where else does $99.95 buy you a Logic Probe, capacitance measurement, transistor gain function (hFE), and 24 DMM ranges including resistance to 2000 megohms? Nowhere else.

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DM20L Pocket-Size w/Logic $79.95*

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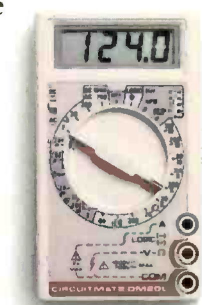
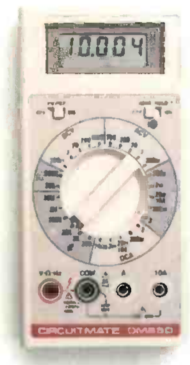
- Ohms-8 ranges (200 ohms to 2000 Megohms)
- Continuity beeper



DM850 True RMS

- 4½ digits. DCV accuracy is .05% +3 digits
- True RMS
- Frequency counter to 200KHz
- Data Hold display capability
- Continuity beeper
- Built-in bail
- Anti-skid pads
- Price: DM850 (True RMS)....$219.95* DM800 (Average) $195.00*



DM25L Capacitance, Logic, hFE $99.95*

- TTL Logic Probe: 20MHz Hi/lo/off indications Detects 25nS pulse widths
- Capacitance: 5 ranges (2nF to 20μF)
- hFE (NPN or PNP): 1 range (1000)
- Continuity beeper
- Built-In bail
- Anti-skid pads

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*Suggested list price ($US) with battery, test leads and manual.

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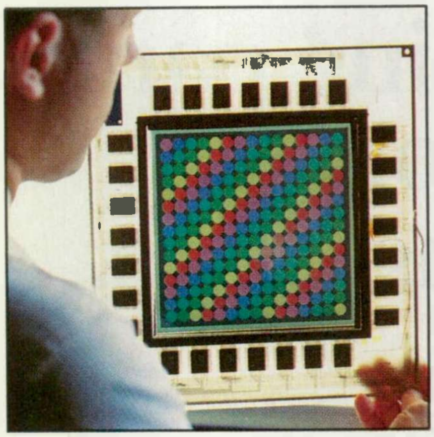
Circle (1) on Reply Card

The how-to magazine of electronics...

ELECTRONIC Servicing & Technology

Volume 7, No. 12 December 1987

On the cover...
Many suppliers, including companies who are more commonly known for selling TV parts, offer a wide selection of replacement parts, tools and information. (Photo courtesy of Philips ECG.)



page 6
GE's high-resolution, large-scale LCD, which has twice the sharpness of a home TV screen, offers promise for TV technology.

page 12
Finding the proper replacement parts can sometimes lead you on a wild goose chase. However, there are many companies that can help you find the right replacement for the job at hand.

Departments:

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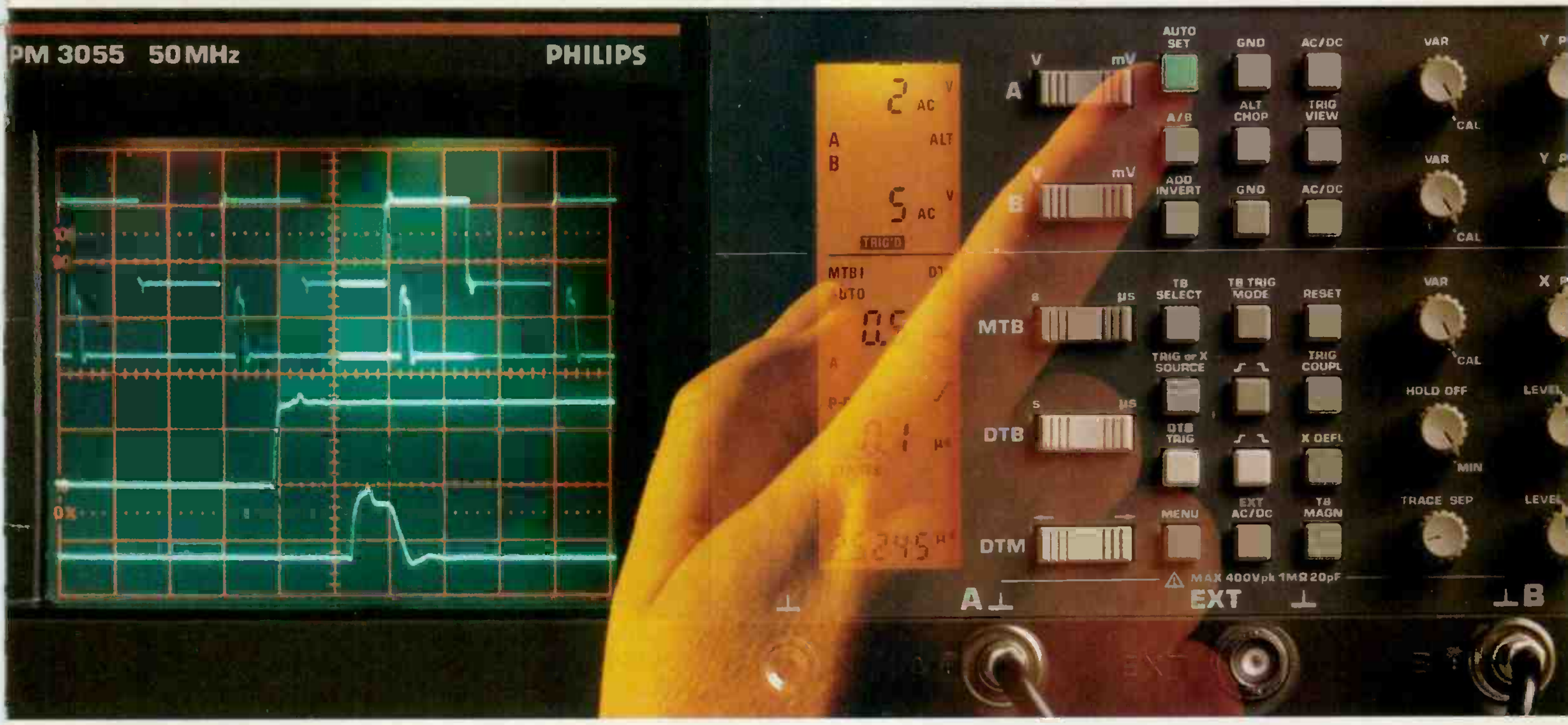

The smart scope for people who hate to wait

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Circle (9) on Reply Card

Parts is parts

There are few things more frustrating than using your skills to diagnose a problem in a television, exercising skills honed over years of application to desolder and liberate a part from the circuit, and then, when you try to order a replacement, finding that you can't get one. The distributor says it's on backorder from the manufacturer, or that it's a special part and he doesn't handle that manufacturer's parts. Or you contact the manufacturer and you find that because that's a relatively new product, there's no established level of spares and it will be a while before there are any available; or yes, there are spares available, but they require a minimum order of $50; or they will not sell to you because you're not an authorized servicing facility.

For the time being, at least, your efforts have gone unrewarded. The set sits lifeless on the shelf. Not only that, but you now have more work to do: contacting friends, other distributors, mail-order houses to find out if there's anywhere you can find a replacement part.

Actually, in the overall scheme of things, this kind of problem doesn't crop up that often. But when it does happen, it overshadows the easy fixes simply because of the frustration level and the inordinate amount of time these problems take to correct. And, unfortunately, it happens often enough.

Not only that, but as time goes on it's likely to happen *more* often rather than *less* often. Take a look at the current manufacturers' schematics for televisions, VCRs, CDs. In almost every case you'll find symbols for integrated circuits that contain a number of complete functions. For example, I'm looking at one now that contains the video amp, noise cancellation circuitry, all of the AGC circuitry and the sync detector. Another IC contains the FM detector and the audio amp.

More and more often, for excellent reasons of design integrity and economics, whole chunks of circuitry that once took a couple of handfuls of components, yards of wire and several ounces of solder to put together are now manufactured in the form of a tiny IC chip.

Some of these chips are standard, designed and manufactured by an IC manufacturer and used by many manufacturers. These ICs are generally available from a number of sources, and if you can't find the specific manufacturer's numbered part, you can find an equivalent from Phillips ECG, RCA SK or New Tone, much as you would find an equivalent transistor, resistor or capacitor.

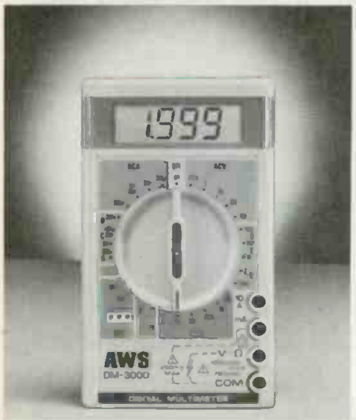
Unfortunately, in these days of massive mass production, it is sometimes cost effective for a manufacturer to design a special circuit and have an IC manufacturer fabricate it for him. In such a case, lines of supply for replacements may be narrow and finding a source for the part might require some fancy footwork.

Problems ordinarily occur at the end points of the cycle: at the beginning before a demand level has been established, and at the end as demand is tapering off. Other problems occur with specially manufactured parts that are proprietary, when the manufacturer decides to control the distribution of those parts. In that case only "authorized" servicers are allowed access to those parts. This has happened recently with personal computers, and it causes a great deal of difficulty to other people who wish to service these products.

Still, the replacement parts supply system works pretty well in most cases. If the demand for a particular part is there, someone will find a way to fill it and make a profit in doing so. (One place to look is the list of parts suppliers on page 15 of this issue.) If you're having difficulty finding a specific part, it's probably out there somewhere just waiting to be found. Keep looking.

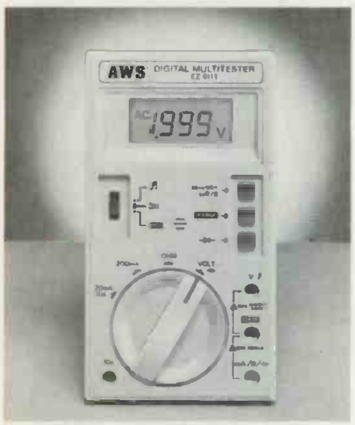
Nils Conrad Persson

AWS MULTIMETERS



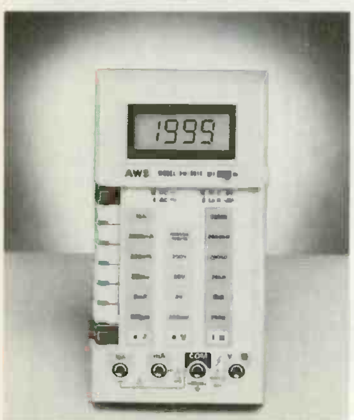
DM-3000 3½ DIGIT ROTARY SWITCH DMM

Just one of three DMM's in our Economy Series that combines quality with economy. Features include built-in HFE, battery and diode testing; conductance function; 300 hour battery life; 10Adc range; electronic overload protection on all resistance ranges; pocket-sized. (Also available models DM-1000 & 2000). **Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-200μ/2m/20m/200m/10Aac/dc; 0-200/2K/20K/200K/2M/20M Ω ; 1.5V battery test; 0-1000 Hfe test; 2K Ω diode test. DM-1000: **$44.95**/ DM-2000: **$54.95** / DM-3000: **$74.95**



EZ-6111 3½ DIGIT AUTORANGING DMM

Unique and sophisticated in design, you'll find measurement taking a breeze. Loaded with features like autoranging in volts and ohms; manual range selection in all functions; diode test function; audible continuity indication; normal and low power ohm ranges; 10Aac/dc range; overload protection on all ranges; 300 hour battery life. Ranges: 0-200m/2/20/200/1000Vdc; 0-2/20/200/600Vac; 0-20m/200m/10Aac/dc; 0-200/2K/20K/200K/2MΩ ; 0-2K/20K/200K/2MΩ LoΩ **$104.95**



DM-3010 3½ DIGIT PUSH BUTTON DMM

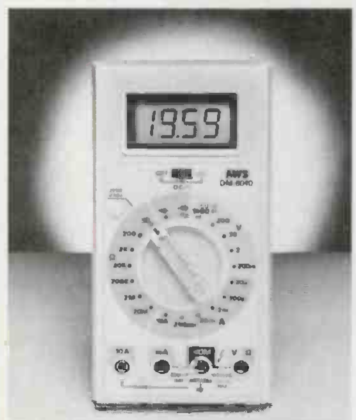
The standard in tough, job-proven digital multimeters. Housed in shock resistant ABS plastic, you'll find safety was a prime design consideration. Also equipped with overload protection on all ranges; special electronic protection to 500Vac/dc on resistance ranges; UL1244 type test leads; normal and low power ohm ranges; 10Aac/dc range; auto zero and auto polarity; built-in tilt stand. Ranges: 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-200μ/2m/20m/200m/2/10Aac/dc; 0-200/2K/20K/200K/2M/20MΩ . **$80.00**

DM-6500 3½ DIGIT AUTORANGING DMM

This sensitive yet rugged instrument is loaded with features you'd expect to pay much more for. The 6500 offers autoranging; low battery consumption; fuse protection; safety test leads; audible continuity buzzer; auto zeroing; shock resistant housing. Ranges: 0-200m/2/20/200/1000Vdc; 0-2/20/200/600Vac; 0-200m/10Aac/dc; 0-200/2K/20K/200K/2MΩ. **$99.95**

DM-7010 4½ DIGIT ROTARY SWITCH DMM

High accuracy readings in the laboratory or in the field. Features include 4½ digit 19999 max. display; built-in frequency counter to 200KHz and conductance function; 0.05% basic dc volts accuracy; overload protection on all ranges; special electronic protection to 250Vac/dc on resistance ranges; UL1244 type test leads; diode and continuity tests. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-200μ/2m/20m/200m/2/10Aac/dc; 0-200/2K/20K/200K/2M/20MΩ; 0-200nS conductance; 0-20K/200KHz frequency. **$179.95**



DM-8010 3½ DIGIT ROTARY SWITCH DMM

This easy to use DMM features a dc Volt accuracy of 0.25% of reading; overload protection on all ranges; special electronic protection to 500Vac/dc on resistance ranges; instant audible continuity buzzer; UL1244 type test leads; auto zero and auto polarity; diode test function; built-in tilt stand. **Ranges:** 0-200m/2/20/200/1000Vdc; 0-200m/2/20/200/750Vac; 0-20μ/200μ/2m/20m/200m/10Aac/dc; 0-20/200/2K/20K/200K/2M/20MΩ . **$84.95**

DM-6592 ELECTRO-PROBE™ DMM

One of the smallest, most convenient hand-held DMM's you'll ever own. It's both autoranging and manual and is the perfect instrument for taking readings easily and accurately in hard to reach areas. Other features include instant audible continuity buzzer; one-hand operation; electronic overload protection on all ranges; data-hold button. Ranges: 0-200m/2/20/200/500Vdc; 0-2/20/200/500Vac; 0-200/2K/20K/200K/2000K/20MΩ **$70.00**

DM-1 POCKET-PRO DMM

Big features are packed in this pocket-calculator sized DMM. You'll find autoranging, manual ranging, electronic overload protection on all ranges, auto polarity, audible and visual continuity indication, built-in test leads, "booklet-type" carrying case is designed to fit easily in shirt pocket. **Ranges:** 0-2000m/20/200/450 Vac/dc; 0-200/2000/20K/200K/2000KΩ; 0-200Ω continuity. **$34.95**

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Circle (10) on Reply Card

Test your electronics knowledge

By Sam Wilson, CET

1. Ultrasonic transducers for fluid flow employ the ________ principle.
2. What is the output voltage for the transformer connection in Figure A? ______ V.
3. What is the output frequency of the phase-locked loop (PLL) in Figure B? ______ Hz.
4. What is the output frequency of the PLL in Figure C?

Wilson is the **ES&T** electronics theory consultant.

5. The circuit in Figure D is equivalent to
   A. an SCR.
   B. a TRIAC.
   C. a Darlington.
   D. (None of these is correct.)
6. A silicon transistor is used for the Class A amplifier in Figure E. What is the approximate value of the base current?
7. What is the approximate value of collector current for the Class A amplifier in Figure E?
8. Assuming the proper time constant, Figure F shows
   A. an integrating circuit.
   B. a differentiating circuit.
9. Which of the following is a reason for preferring a MOSFET over a bipolar transistor in an RF amplifier circuit?
   A. Low noise
   B. Low input impedance
10. The number 2.7182818 is represented on a calculator as ________.

Continued on page 61

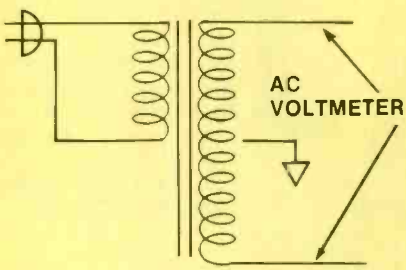

FIGURE A

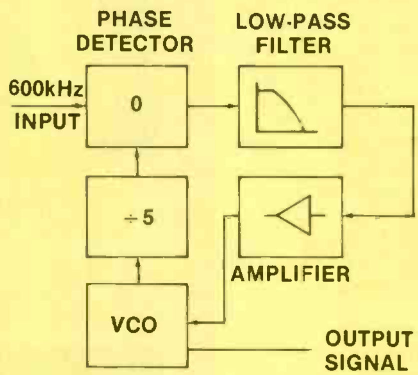

FIGURE B

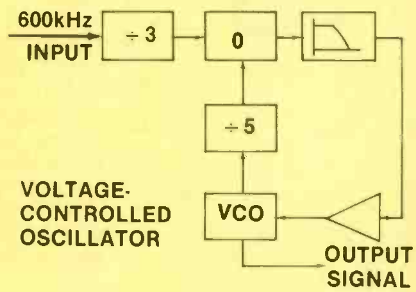

FIGURE C

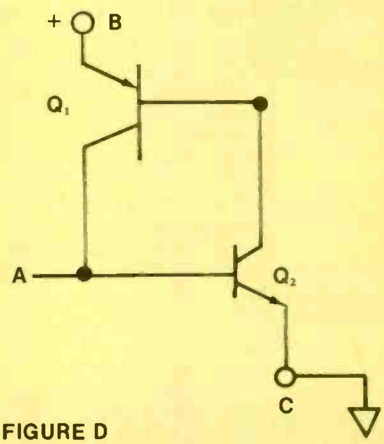

FIGURE D

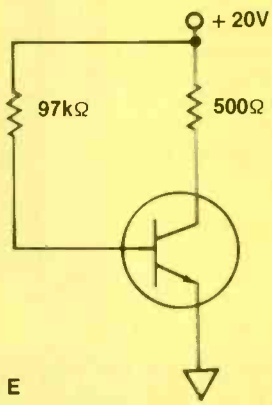

FIGURE E

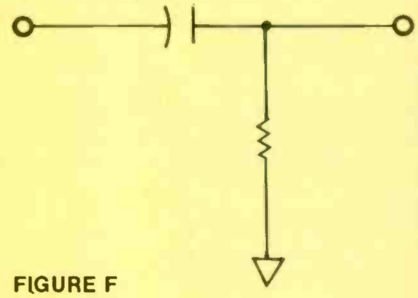

FIGURE F

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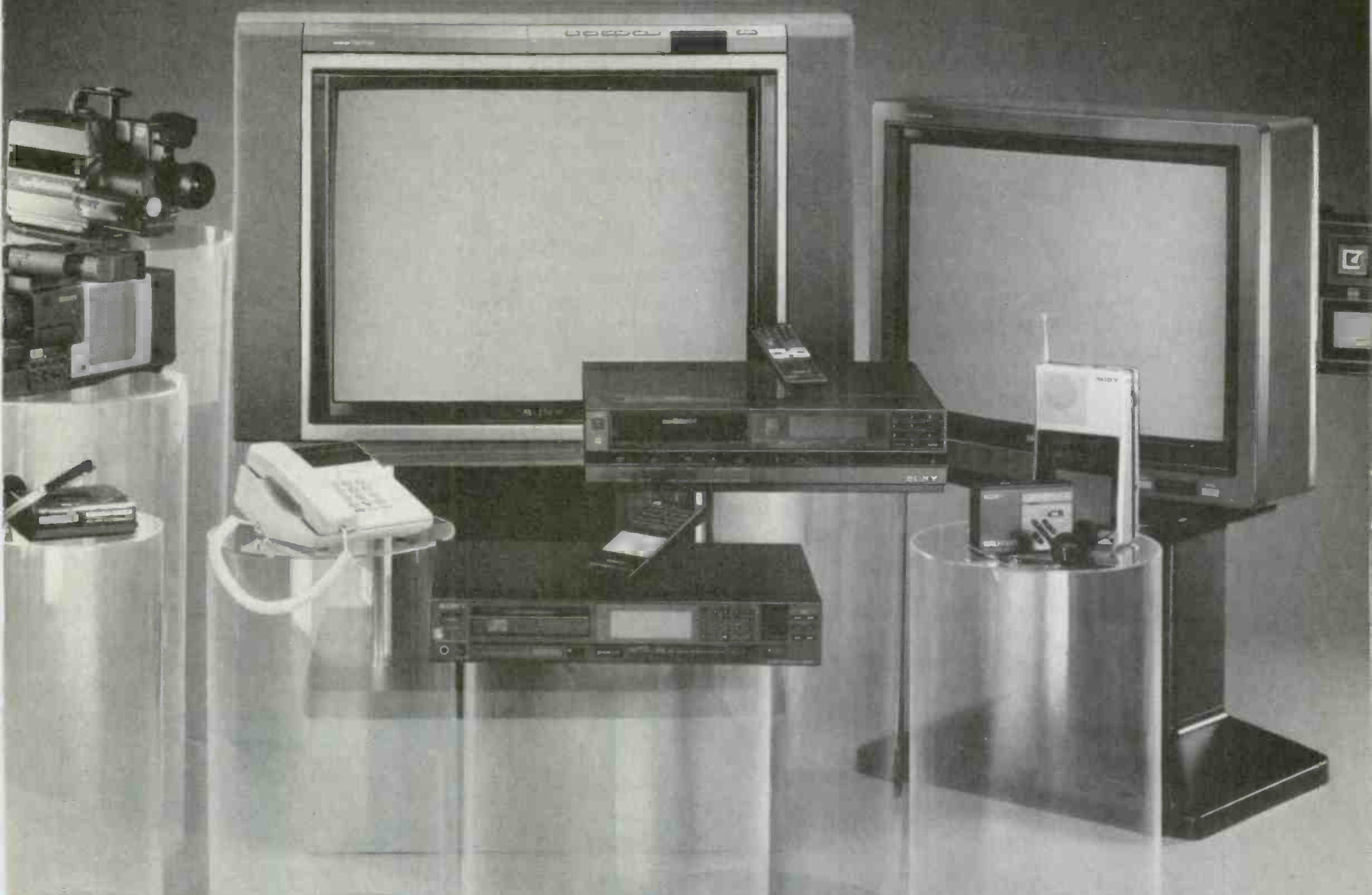

Your customers may never need The Sony Service Company, but it's comforting to know we're only a phone call away.

Our nationwide network of Sony Service Centers, Training and Technical Departments and our National Parts Center represent our commitment to service. This means if you sell or service Sony products, Sony is there for you. Read on to find out more.

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2. Regional Centers. Our Regional Centers are set up to assist you with any technical questions. Just call one of the following numbers. Mahwah, NJ (201) 529-1616; Philadelphia, PA (215) 632-7999; Irving, TX (214) 258-1167; Fort Lauderdale, FL (305) 920-5656; Honolulu, HA (808) 834-6622; Niles, IL (312) 647-0244; Detroit, MI (313) 477-4805; Costa Mesa, CA (714) 549-4836, San Jose, CA (408) 280-7675.

3. Training & Technical Departments. Because constant innovation is the rule in the field of consumer electronics, authorized servicers and Sony Service Center technicians need the latest information available. This information is provided through training sessions at our Regional Training facilities and publication of Service Bulletins by our Technical Department.

4. National Parts Centers. All Sony Service Centers, parts distributors and authorized servicers depend on the National Parts Center. The Center also provides up-to-date service manuals and training tapes. To receive the Comprehensive Service Literature brochure free of charge write: Sony Service Company, National Parts Center, 8281 NW 107th Terrace, Kansas City, MO 64153 Attention Publications Department or call (816) 891-7550.

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News

UL proposes ANSI standards

Underwriters Laboratories (UL) is currently proposing several safety standards for recognition as American National Standards:

• UL 1412, the Standard for Safety for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances, covers fusing resistors and temperature-limited resistors for use in radio- and television-type appliances in circuits that do not involve potentials greater than 2,500V peak. Mounting assemblies intended for use with such resistors are also covered.

• UL 1413, the updated Standard for Safety for High-Voltage Components for Television-Type Appliances, covers flyback transformers, high-voltage multipliers, deflection yokes and picture-tube high-voltage neck components intended to be employed in television-type appliances.

The proposed standard is a revised version of ANSI/UL 1413-82.

• UL 1417, the updated Standard for Safety for Special Fuses for Radio- and Television-Type Appliances, covers special types of fuses that are not covered by separate requirements and that are for use in radio- and television-type appliances where they are relied upon to limit power or current.

The proposed standard is a revised version of ANSI/UL 1417-82.

UL is seeking review and comment from interested individuals and organizations to help develop a consensus upon which recognition of UL 1412 by the American National Standards Institute (ANSI) can be based, and upon which continued recognition of UL 1413 and UL 1417 by ANSI can be based. ANSI is a clearinghouse for information on standards and coordinates development of national consensus standards through voluntary action.

Anyone interested should contact L.M. Cohen at UL, 333 Pfingsten Road, Northbrook, IL 60062 (312-272-8800, ext. 2693) and request free copies of UL 1412, 1413 and 1417.

EIA forecasts electronics industry growth in '88

The Electronic Industries Association (EIA) is predicting that 1988 U.S. factory sales of electronic equipment, components and related products will approach $238 billion, or 6.2% over forecasted 1987 factory sales figures. The association is also predicting that 1987 sales will reach almost $225 billion by the end of this year (5.3% over last year's total sales figure of $213 billion).

In examining the major sectors of the industry, the EIA marketing services department forecasts growth in these markets:

• Consumer electronics: Sales increases for 1988 are expected to be slightly less than in 1987, which saw an 8% increase over 1986 sales in color televisions to U.S. dealers.

• Telecommunications equipment: Although 1987 sales are expected to increase at a rate below the total electronics industry (caused by fewer military orders), improvement is expected in 1988.

• Computer electronics: Computer industry sales are expected to grow 6% to 10% in 1987 and 10% to 19% in 1988.

• Electronic components: Sales are forecasted to reach almost $40 billion in 1987 (up 6.4% from 1986, with a 20% increase in semiconductor sales) and to increase 8% to 19% in 1988. ES&T

The how-to magazine of electronics

ELECTRONIC Servicing & Technology

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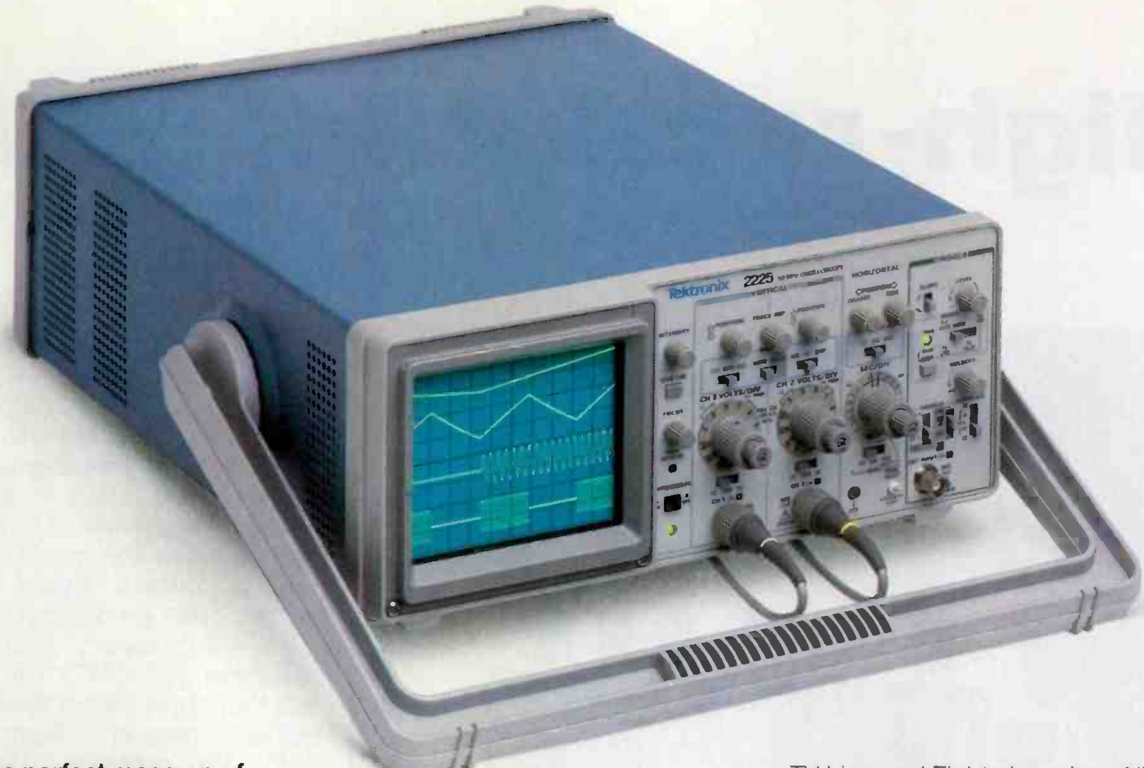

Now, the perfect measure of economy plus performance in a low-cost, 50 MHz scope backed by a 3-year warranty. The new 2225 exemplifies Tek quality at its pure and simple, affordable best. It's the easy, economical answer to your professional scope needs at bench and field sites, on the manufacturing floor and in the classroom.

Two-channel, single time-base Tek basics enhanced by features of much more expensive scopes. Plus outstanding ease of use. You get 500 μV/div vertical sensitivity for low-level signals. Horizontal alternate sweep magnifications of X5, X10 and X50 for time measurement accuracy. New front-panel Z-axis input. HF and LF Reject trigger filtering to stabilize noisy-signal displays. Plus TV Line and Field triggering. All in a compact, portable package.

Two heavy-duty Tek 10X modular probes with a new ruggedized probe tip are included.

Bandwidth	50 MHz
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Trigger Couplings	AC, DC, HF Reject, LF Reject
Weight	6.6 kg/14.6 lb
Warranty	3-year on parts and labor, including CRT

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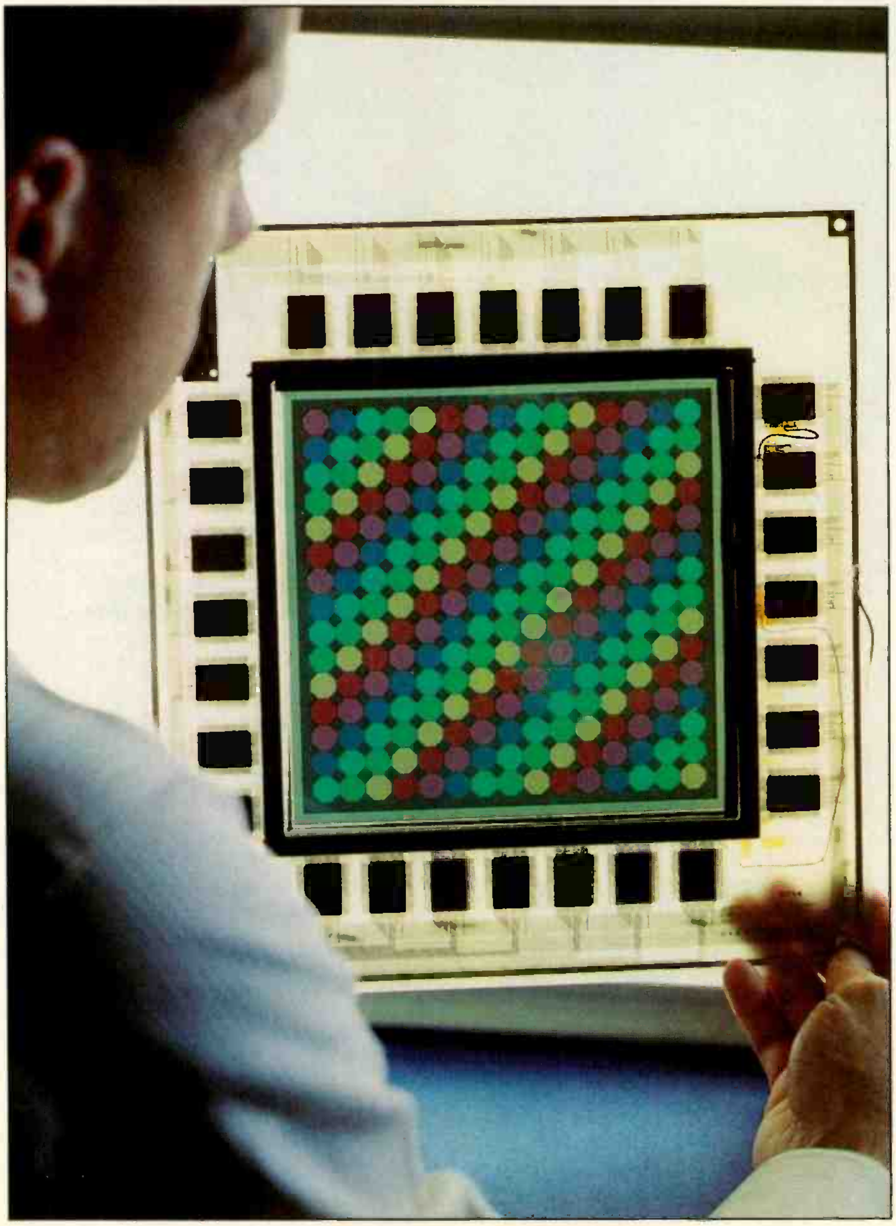

TV technology could ultimately benefit from research and development on flat-panel LCD displays recently conducted by GE. The GE Research and Development Center, in a joint effort with the GE Aircraft Instruments Department, has designed the world's largest high-resolution liquid crystal display panel for aircraft cockpits.

The full-color, flat panel measures 6¼"x6¼". The LCD is less than three inches thick and requires a turn-on voltage of only 15V. By contrast, the glass cathode ray tube (CRT) is 14 inches thick and requires 17,000V for turn-on.

The display owes its high resolution to the large number of pixels (the dots that are activated to form an image) in its screen. The display has more than 2,800 pixels per square inch (more than one million total), which gives the LCD twice the sharpness of a home TV screen.

The high-resolution image is a result of thin-film transistors positioned at the corner of each pixel. Each transistor provides a switch that turns the liquid crystal material on or off at that point, enhancing contrast between light and dark areas and improving the viewing angle. The transistors consist of a metal gate, a thin film of hydrogenated amorphous silicon nitride and amorphous silicon, and a metal source and drain. The silicon nitride and amorphous silicon layers are laid down via plasma deposition at relatively low temperatures of less than 650°F, which makes it possible to fabricate large arrays of transistors directly on the glass plates without causing them to melt.

Liquid crystals are fluids that flow like a liquid but have some of the optical characteristics of solid crystals. They are transparent in their normal state, but when voltage is applied, they become opaque, transmitting available light.

GE has sandwiched the liquid crystals between two flat plates of glass. The inner sides of the glass are patterned with silicon structures that control the electrical charges that "paint" the alphanumeric characters or images on the LCD's screen. A dimmable fluorescent backlight provides a high-contrast image over an ambient brightness range from full sunlight to the dark of night, and red, blue and green filters provide a full-color picture.

The LCD is designed to meet military specifications and can be programmed to display engine performance, logistic and ballistic data, altitude reference, radar images and video. The European rights to the technology are licensed to Eurodisplay, a subsidiary of Thomson-CSF, France, and VDO Luftfahrt, West Germany.

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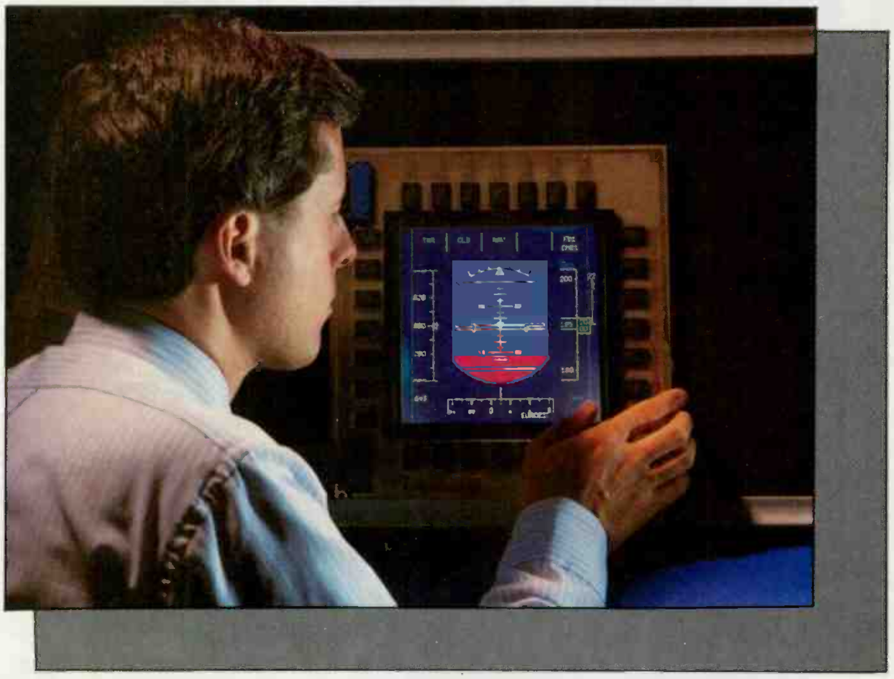

Locating replacement parts

By Conrad Persson

The TV, VCR or personal computer is lying open on your workbench. You've applied all your diagnostic skills, probed with meter, scope and a handful of other test equipment, and you've finally isolated the cause of the problem – one or more of several parts on a printed circuit board.

It's been quite a struggle, but victory is in sight. You take the soldering iron in hand and carefully liberate the troublemakers from the board. If life were fair, the war would be won. All you would have to do is locate the correct replacement in your inventory, solder it in and perform the smoke test.

Life is not fair, however. Often, the end of the struggle to locate the defective part merely signals the beginning of the struggle to locate a suitable replacement. There are the older units that have become obsolete and for which replacements are no longer made. There are the manufacturers who require a hefty minimum order before they'll ship any parts. There are the units for which you can't find any servicing information. And many times you either use a universal substitute you have on hand or order a universal substitute and find that the pin arrangement is not quite the same.

This article, based on information, tips and hints found in parts catalogs from Philips ECG, General Electric, MCM, Motorola, NTE, RCA-SK, Workman Electronics, Zenith and others, is intended to provide you with information that will help you find and select the right replacement part. It will also suggest ways to ensure that the replacement does the job for which it was intended.

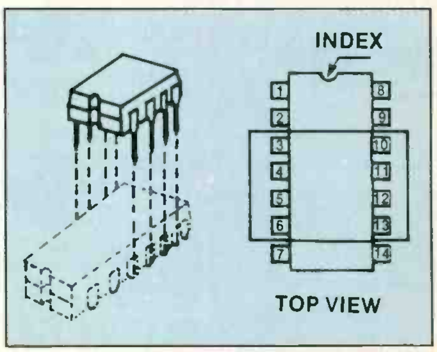

Figure 1. Some linear IC devices that were originally supplied in 14-lead DIL case are now available in 8-pin mini-DIP cases. The pins 1, 2, 7, 8, 13 and 14 were not connected in the original version, so the 8-lead package can be installed as shown.

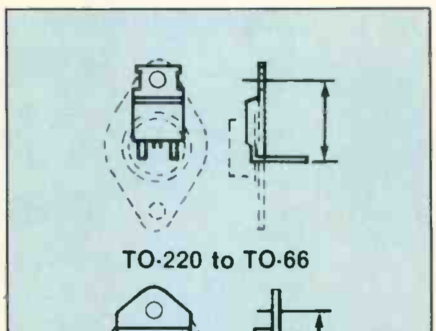

Figure 2. Some plastic-case devices are direct retrofits for metal-case types. Just cut the center lead of the plastic device and bend the two outside leads.

Persson is editor of ES&T.

RF considerations

Any time you substitute a universal replacement for an original-equipment component in an untuned amplifier stage operating at a low signal level (for example, the untuned RF-amplifier [antenna] stage of the radio receiver, or a low-level AF-amplifier stage), it usually is not necessary to make any circuit adjustments to assure proper performance of the equipment. However, when a replacement is made in a tuned RF-amplifier stage, RF-oscillator, converter or IF-amplifier stage, it is always advisable to check the alignment of the associated tuned circuits to assure proper tracking and to achieve the required gain without loss of stability.

Considerations in high-power stages

When making a replacement in a stage that operates at relatively high power levels (such as Class A and Class B AF output stages of automobile radios, phonographs and AF-amplifier systems), the transistor bias should be checked and adjusted, if necessary, to protect the replacement transistors against excessive dissipation and to minimize distortion. Means for making such adjustments are generally provided in the equipment, and the necessary instructions are usually given in the equipment manufacturer's service data.

Using replacements properly

When you install a universal replacement in an FM tuner, TV tuner or other circuit operating in the VHF or UHF regions, it is extremely important not to change any of the mechanical details of the original circuit. Before removing the original transistor, carefully note its position with respect to other circuit components. Also note the lengths and placement of the transistor leads, and duplicate these details as precisely as possible with the universal replacement transistor. If you don't do this, the result could be improper tuning or circuit instability, particularly in UHF TV tuners.

The same holds true for using replacement integrated circuits in place of an original-equipment type in FM radios and TV receivers. Be careful to note the IC's position and lead placement.

Replacing 14-pin ICs

You may run across situations where a replacement IC for a 14-lead linear DIP (dual-in-line package) IC comes with only eight leads. In this case, pins 1, 2, 7, 8, 13 and 14 are not connected to anything internally in the package, so the 8-pin package is a direct plug-in replacement. The 8-pin replacement should be installed as shown in Figure 1.

Be careful with stud-mounted devices

When you're trying to replace a stud-mounted device, it sometimes isn't possible to find a replacement with exactly the same thread and stud size as the original. In this situation, the device may be replaced with a device that has the same size or larger stud.

If you must use a component with a larger diameter stud, be careful that you don't enlarge the mounting hole any more than 1/64th of an inch larger than the replacement component's stud. Also, the edge of the hole should have a chamfer not exceeding 0.01-inch radius. It is also important that the mounting hole be drilled perpendicular to the surface within 1/10 of a degree. You should use heat sink compound between the heat sink and the replacement unit.

The mounting hardware usually consists of a nut and either a pal or a lockwasher. Either type will work as long as the proper torque is applied. A good torque wrench is a necessity.

Replacing a metal-case device

The JEDEC TO-220 outline is a direct retrofit for devices in the JEDEC metal TO-66 case. Likewise, the CP-3 plastic device can be used to replace types in the JEDEC TO-3 metal case. In either of these cases, you make the replacement by cutting the center lead of the plastic device and bending the two outside leads to install the device. (See Figure 2.)

Some other precautions

There are many other precautions to be observed in handling replacement components. We will just mention some of them here, as

Choosing an alternative vendor

The following are edited comments from Gershon Cooper, president of ORA Electronics, suggesting how to choose an alternative parts vendor.

Many popular parts, particularly semiconductors for products of Japanese manufacturers, are now available from alternative parts sources, frequently at prices below the manufacturers' prices. Many of these alternative suppliers stock a variety of replacement parts, plus other technician aids, installer aids and accessories. The semiconductors stocked are the same as those supplied by the original manufacturer. Some unscrupulous companies offer surplus parts re-marked with the part number, so care should be taken when dealing with replacement parts vendors.

How to choose a vendor

Most alternative parts vendors are catalog operations. The company publishes a catalog that is mailed to service dealers. The catalog lists and describes all available parts and a phone number is provided to place the order. By looking at the catalog, reviewing the sales terms and conditions, and talking to the people on the phone, you can learn a lot about the operations of the company and then decide which company will get your business.

Words of advice

Deal only with reputable companies. If you receive frequent catalogs or sales flyers, check to see whether the catalogs/flyers are neat, printed on a decent paper, and show clear pictures of the products. This will tell you a lot about the reputation of the company.

Deal with companies that offer toll-free numbers. A toll-free number is a good indicator that you're dealing with a large, established company. Deal with companies that offer you such services as fast delivery and on-line information on in- and out-of-stock items. Deal with companies that offer easy return privileges for unacceptable and defective parts.

After receiving an order from a company, check:

1) How long it took for the order to arrive. If the parts are cheap, but it takes a long time (more than one week) to receive the order, then you are the loser.
2) How are the products packaged? Paper bags, newspaper and other cheap materials can allow the goods to be damaged.
3) How much of what you ordered actually arrived? It should not be less than 70%.
4) Is the invoice clear? Are all charges reasonable? Avoid buying from companies that charge for handling or charge surcharges. Reputable companies charge freight only in the amount charged to them by the carrier, and never charge surcharges for credit card transactions or handling charges. Also avoid dealing with companies that charge freight and other charges on a percentage basis; i.e., $5 on orders up to $70; $10 on orders $70 and up; or 10% for orders up to $100, and 5% for orders $100 and up.
5) Is your order accurate? Mistakes do happen, but an excessive number of mistakes is a clear sign of a problem company.

many of them were covered in the article, "Replacement Parts," published in the June 1986 issue. Other problems to watch for, such as ESD (electrostatic discharge), which was covered in detail in our October issue, have been discussed in recent issues. To eliminate handling damage, use the following precautions:

• In order to avoid electrostatic discharge damage to a static-sensitive replacement part, don't open the static-shielding package until you're ready to install the part. Make sure you're wearing a static-grounding wrist strap when you handle static-sensitive parts, and make sure your workbench is clear of any material that might be carrying a static charge. With today's advanced technology sets, a lot of the components are static sensitive, so some manufacturers recommend working at all times as though the components you're handling will be damaged if you don't observe static handling precautions.

• Use the right sized soldering iron and proper soldering techniques, and limit the amount of time you hold a soldering iron in contact with the component's leads. Most components are heat sensitive, and if you're not careful while soldering in a replacement component, you might destroy it before it ever sees service. If you think a component might be damaged by heat even if you're careful, clamp a heat sink or pair of long-nosed pliers around the lead between the component body and the soldering point. This precaution will dissipate most of the heat before it reaches the component.

• When working on a product that uses surface-mount devices, don't desolder a surface-mount IC unless you're absolutely sure that it's defective. These units are extremely delicate and heat sensitive, and they will likely be damaged or destroyed by the removal operation. And *never* place a surface-mount component that you have desoldered back onto a circuit board. If you desolder a surface-mount component, discard it.

• When bending leads to prepare the replacement component to be inserted into the circuit board, always use a pair of pliers or another method to hold the lead near the body of the component to avoid damaging the part.

Sources of replacement parts

Although finding the right replacement part can sometimes seem like an impossible task, the more suppliers you're familiar with, the more likely you'll be able to find the part you need. Some of the suppliers listed in the accompanying sidebar sell through traditional distributors; others sell via mail order. Check them all out. You might be surprised to find that suppliers like Philips ECG, RCA-SK, NTE Electronics, Zenith and others who you thought sold only TV parts can also provide you with replacement digital ICs for computers, remote control units, test meters and more.

Sources of replacement parts

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Union, NJ 07083

All Electronics
905 S. Vermont Ave.
Los Angeles, CA 90006

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401 E. Eighth St.
Fort Worth, TX 76102

Antique Electronic Supply
1725 W. University
Tempe, AZ 85281

Asti Magnetics
32 Piermont Road
Cresskill, NJ 07626

Circuit Specialists
Box 3047
Scottsdale, AZ 85257

Consolidated Electronics
705 Watervliet Ave.
Dayton, OH 45420-2599

Dalbani Corporation of America
785 E. 14th St.
Los Angeles, CA 90021

Dick Smith Electronics
P.O. Box 2249
Redwood City, CA 99063

Digi-Key
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Thief River Falls, MN 56701

Digitron Electronics
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Springfield, NJ 07081

E.S.I.
3171 Hempstead Turnpike
Levittown, NY 11756

Electronic Salvage Parts
2706 Middle Country Road
Centereach, NY 11720

Electronic Parts Supply
741 E. 14th St.
Oakland, CA 94606

Electronics Warehouse
1910 Coney Island Ave.
Brooklyn, NY 11230

Etco Electronics
North Country Shopping Center
Plattsburg, NY 12901

EVG
1 Lee Place
Freeport, NY 11520

Fox International
23600 Aurora Road
Bedford Heights, OH 44146

Fuji-SVEA
P.O. Box 3375
Torrance, CA 90510

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400 South Wyman St.
Rockford, IL 61101

Hitachi
401 West Artesia Blvd.
Compton, CA 90220

Jameco Electronics
1355 Shoreway Road
Belmont, CA 94002

Joseph Electronics
8830 N. Milwaukee Ave.
Niles, IL 60648

Matsushita Engineering & Service
50 Meadowlands Parkway
Secaucus, NJ 07094

MCM Electronics
858 E. Congress Park Drive
Centerville, OH 45459-4072

Mid America Company
2309 S. Archer
Chicago, IL 60616

Milo Associates
4169 Millersville Road
Indianapolis, IN 46205

Mouser Electronics
P.O. Box 9003
Lakeside, CA 92040

NTE Electronics
44 Farrand St.
Bloomfield, NJ 07003

Nippon America
9600 NW 12th St.
Miami, FL 33172

OHM/Electronics
746 Vermont Ave.
Palatine, IL 60067

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New York, NY 10025

Optima Electronics
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Dania, FL 33004

PanSon Electronics
268 Norman Ave.
Greenpoint, NY 11222

Pfanstiehl Chemical Corporation
3300 Washington St.
Waukegan, IL 60085

Philips ECG
100 First Ave.
Waltham, MA 02254

Projector Recorder Belt
200 Clay St.
Whitewater, WI 53190-0176

RCA Special Products
2000 Clements Bridge Road
Deptford, NJ 08096

Richardson Electronics, Ltd.
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Franklin Park, IL 60131

TEC
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Pearl River, NY 10965

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628 Belmont St.
Mt. Carmel, IL 62863

Unity Electronics
P.O. Box 213
Elizabeth, NJ 07206

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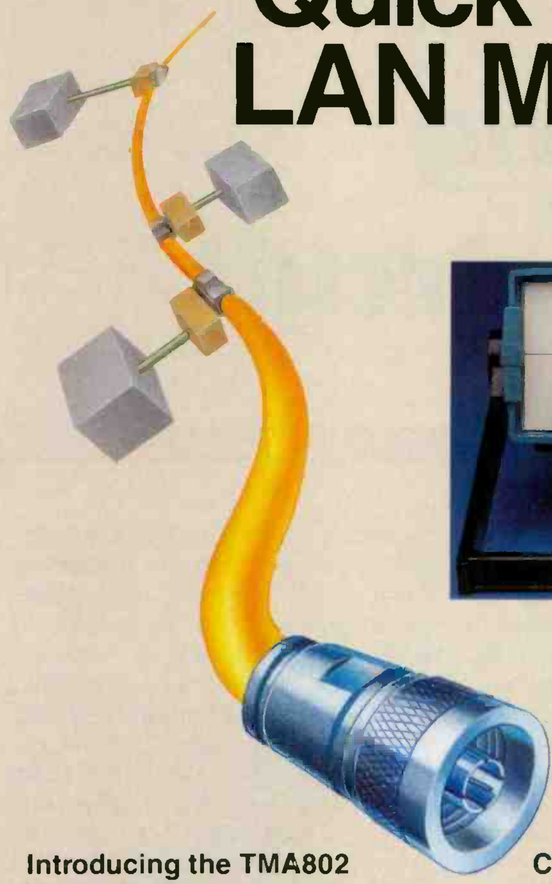

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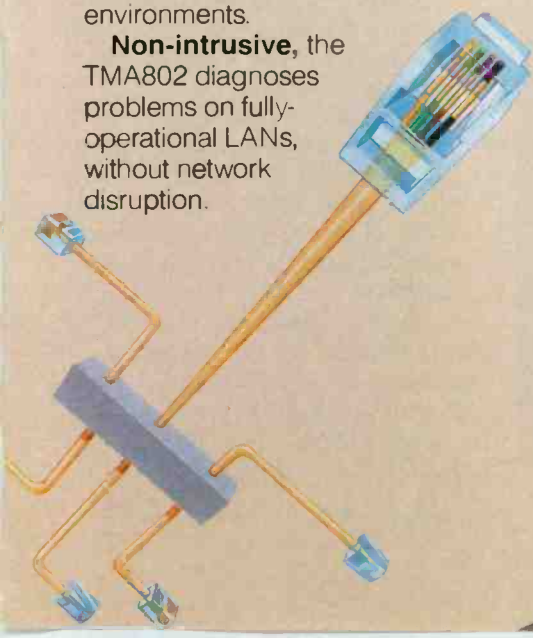

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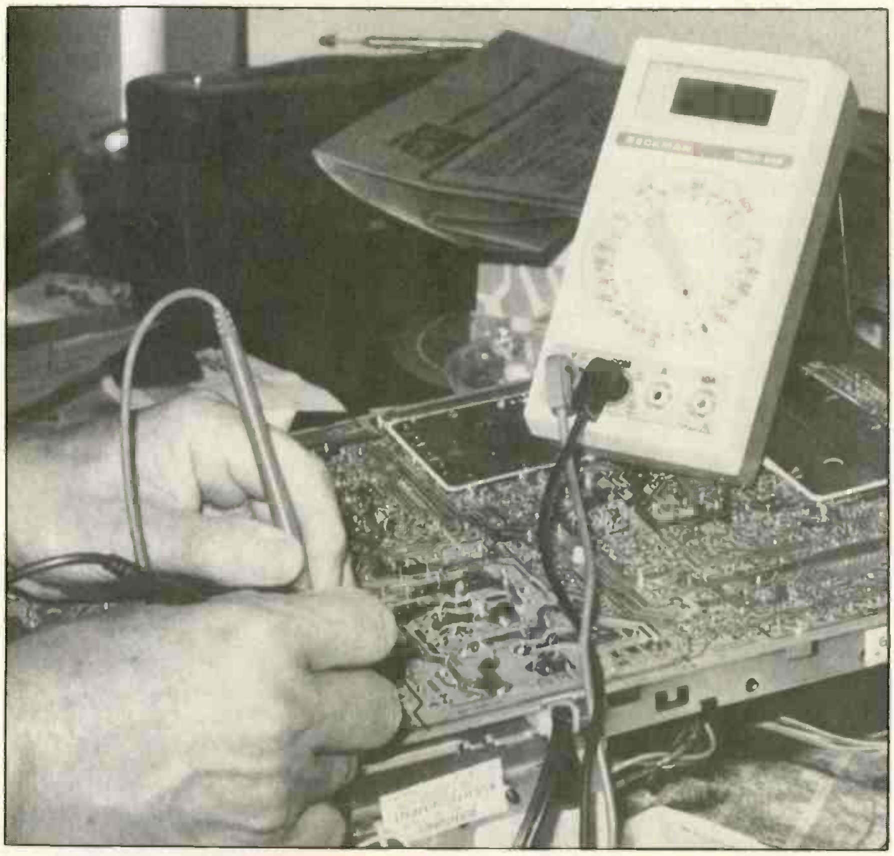
Troubleshooting the chopper circuit

By Homer L. Davidson

All servicing technologies described in this article are well known. Many of the tests commonly used (not mentioned in this article) are not recommended for the CTC131. I have included only those tests that produce good results with little danger of damage. The CTC131 is not a suitable circuit for experimentation. Just restore the original circuit; don't change it.

A person can look at a simplified schematic of the CTC131 chopper system and think, "That circuit isn't so difficult; I can understand how all of it operates." Very true. But that is only because it has been greatly simplified; the complete circuit is nearly incomprehensible. Many resistors were added for voltage drops and current limitings. Diodes were added as switches, as rectifiers and as variable resistors. Many capacitors from small to large capacitance were included for a variety of tasks. A close-packed arrangement of capacitors, resistors, diodes and zeners completely surrounds U401, the regulator-control IC. Any one of the functions (which usually involves one pin of U401) can be traced and eventually understood, but it is difficult. And the difficulty is increased by the cross-coupling between circuits. My advice when you're servicing this power supply is to use the full schematic.



The technician is testing bridge diodes from the bottom of the circuit board. A DMM special diode test is used on the four bridge diodes of the +150V hot supply.

The largest addition to the chopper's simplified schematic is U401, the regulator-control integrated circuit. The following are several of its functions:

- Monitor the high voltage (HV) and shut down the chopper if the HV rises too high.
- Monitor the +129V supply, using it to regulate the dc voltages produced by the supplies powered through T105.
- Monitor the +12V supply.
- The pulse-width-modulation system produces the variable-width pulses that are emitted from U401 at pin 4. These pulses are rectified for the regulated power supplies.

An internal oscillator is locked to the television horizontal scanning frequency to avoid beats.

Regulation in this type of system is accomplished by varying the pulse widths. When narrow dc

Davidson is **ES&T's** TV servicing consultant.

pulses are integrated, the result is a low dc voltage. As the width of the pulses increases, the dc output voltage increases proportionally.

Voltage regulation in the CTC131 can be summed up in this statement: When a higher dc output voltage from T105 is needed, the chopper pulses are widened, producing a higher dc output voltage.

Complete servicing of the CTC131 chopper and power-supply circuits is a complicated procedure. Fortunately, many repairs can be performed after simple measurements and the replacement of a few components.

In most TV receivers, the horizontal-drive and horizontal-output transistor areas receive most of the attention during preliminary testing. This is not the case with the CTC131, where the chopper stages are the most likely to fail; therefore most of the tests involve the chopper.

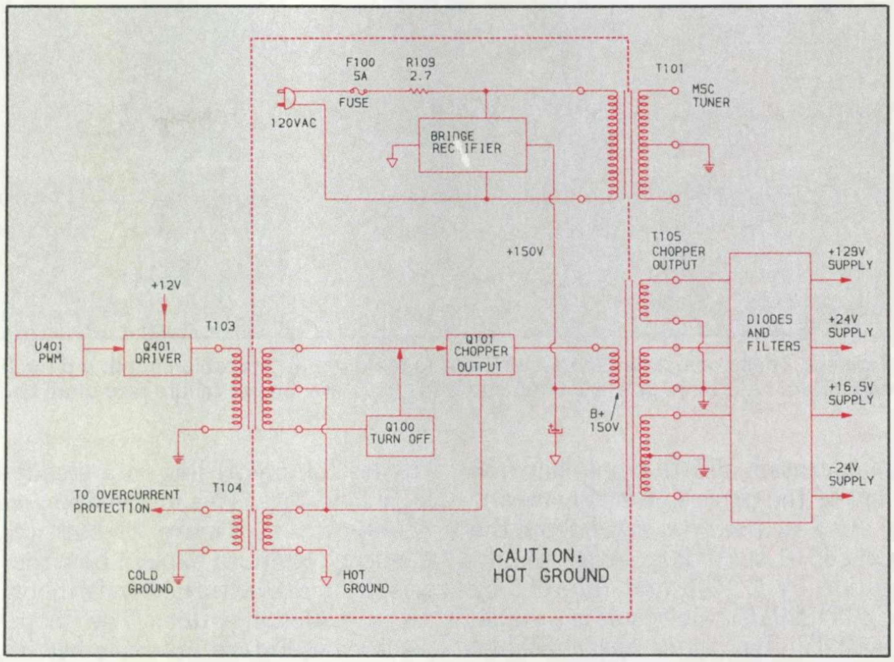


Figure 1. Most of the CTC131 hot 120Vac wiring is contained in the circuits and components inside the area bounded by the lines of large rectangles or blocks. All other wiring uses cold grounds.

The power-makers (and thus trouble-makers) are shown in the block diagram. They should be the first tested when F100 in Figure 1 is found to be blown.

This schematic was carefully arranged so the areas of hot acV wiring and cold acV grounds are clearly differentiated. Everything inside the dotted rectangle is hot. Notice that each of the four transformers has one or more *hot* acV grounds on one side via one or more windings, but they also have *cold* acV grounds at the other side of the same transformer. This is not a new application for transformers. Power transformers, with 120Vac on one side and several secondary windings, became popular. These cold chassis models were greeted many years ago as a major advance in safety over the methods of using rectified 60Hz power without isolation.

Actually, all the CTC131 60Hz wiring (less the degaussing circuit and the tuner power) is contained in the center area of Figure 1. Remember that T101, T105, T103 and T104 are the four transformers with hot primaries and cold secondaries.

Because there is so little 60Hz hot wiring, it appears out of balance to give that much detail about the subject. Yet it always has been part of RCA service meetings. Therefore, hot/cold grounds must be important. Although the CTC131 is not the first RCA to have hot/cold double grounds, it is much more complicated.

An incorrect connection for a quick test on this set is more likely to cause damage than a similar mistake with an older model (one without a chopper).

Circuit descriptions

If you work with these CTC131 chassis without studying the circuitry, the relative failure rate might seem to indicate that the chopper transistors are weak or are just prone to shorting out. Many of the failures end with the Q101 chopper transistor shorted between all pins. Unless some other components are replaced, the new transistor will be ruined almost instantaneously when power is next applied.

Did you know that the chopper is forced to control the largest amount of power of any transistor in the chassis? The output of the chopper supplies four dc voltages. One of those voltages is +129V, which is the regulated B+ for the horizontal-output transistor's collector. The other chopper-regulated voltages (+24V, +16.5V and −24V) power most of the circuits remaining, helped in a small way by two B+ supplies rectified from flyback transformer power.

A full list is not necessary to see that the power load carried by a chopper transistor is much higher than that of any horizontal-output transistor. Later, the circuit and components that reduce the dissipation of the chopper will be discussed.

The schematic condensed

Several items should be discussed before leaving Figure 1. Notice that *there is no on/off switch on the schematic*. That's because there is none for the TV function. The 120Vac is applied continuously, and the +150V voltage is also present, waiting with zero current and maximum voltage for the chopper channel to be activated.

T101 is called the standby transformer because it operates 24 hours a day to power the tuner-control module, even when the television is off. It is a small transformer, mounted on the chassis at the rear. The windings will feel warm after several hours

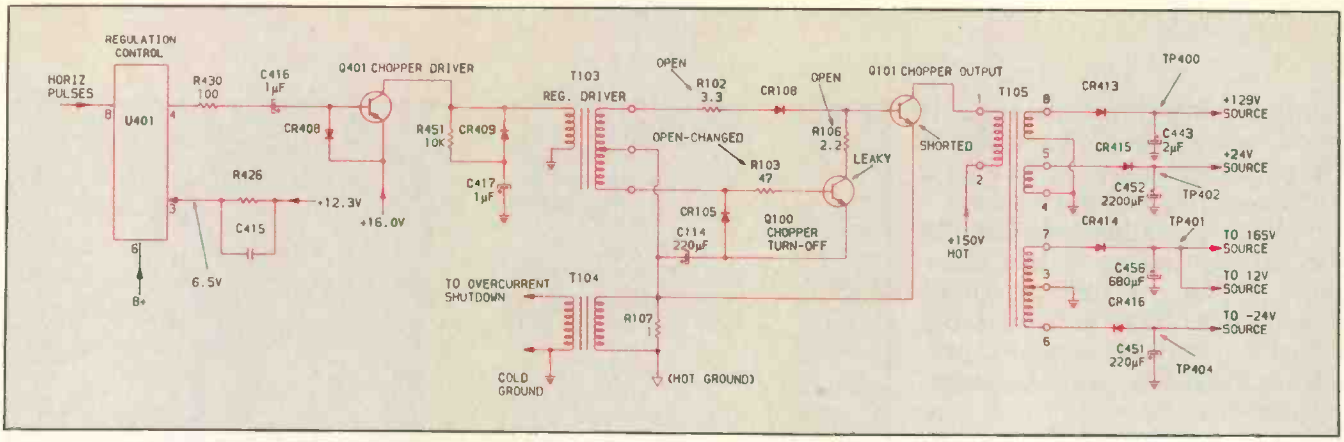


Figure 2. These components are sufficient to make up an operable circuit, although many of the less important resistors and capacitors have been deleted. Q100 and Q101 have the largest failure rate of all components.

of operation. (T101 is not shown in any of the photos or schematics.)

Also, ac power is taken from the cold T101 secondary. After rectification by CR406 and filtering by C463 (220µF), the result is a stable +12.3V that is *always* available. This +12.3V source powers the oscillator and other essential sections in U401. Without it, start-up would be impossible.

Some of the following can be checked only by studying a complete schematic. When the front panel on/off button or the remote control on/off button is pressed, the tuner-control module delivers a logic low that reverse-biases CR426 in the overcurrent-shutdown circuitry. This starts the power supplies and chopper into operation. However, the low is just a short pulse, and the operation would soon stop except for +30V, which is produced by rectification of flyback pulses. A sample of the +30V is fed to the tuner-control module and a certain IC that latches the on/off line to a steady logic low state. This information is not shown in Figure 1, but we mention it here to explain how the television can be turned on without a conventional switch. (The chopper area in Figure 1 is explained in detail later, along with accompanying schematics. Therefore, the explanations will be general in nature until then.)

The width of the pulses produced in the pulse-width modulated (PWM) area of U401 undergoes constant changes as part of the regulation process. The pulses then exit at pin 4 before being sent to the base input of Q401, the chopper-driver transistor.

The next stage would appear to be a normal transformer-coupled amplifier except for turn-off transistor Q100. Notice that Q101 is the only load connected to the hot +150V supply. After diode rectification and filtering, four secondary windings on T105 produce three major B+ and one negative supply. (These are discussed later.) Also, the bridge rectifier consists of four separate diodes.

PWM and the chopper

As shown in Figure 2, the PWM chopper-regulated power supply consists of three transistors, three transformers and one IC regulation control.

Values of a paralleled resistor and capacitor at U401 pin 3 determine the free-running frequency (about 15kHz) of the regulation-control RC oscillator. Locking is accomplished by horizontal pulses brought from T401 flyback to U401 pin 8. The locking is necessary to prevent beats and interference that could occur if the frequencies were different and the chopper signal radiated into the television signal circuits.

At U401 pin 4, the output signal of the regulator control (which consists of segmented, variable-width pulses) is capacity-coupled to the base of Q401, the chopper

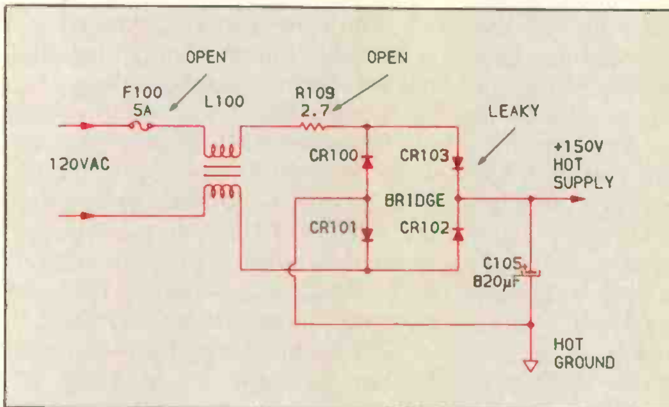


Figure 3. Fuse F100 (5A) and R109 (2.7Ω) will be blown by excessive 120Vac current. Resistor R109 is a special number and is soldered into place, so it is best to find the problem with the 120Vac power turned off, if possible. Test all four bridge diodes in-circuit for both forward conduction and reverse-polarity leakage, then continue the tests.

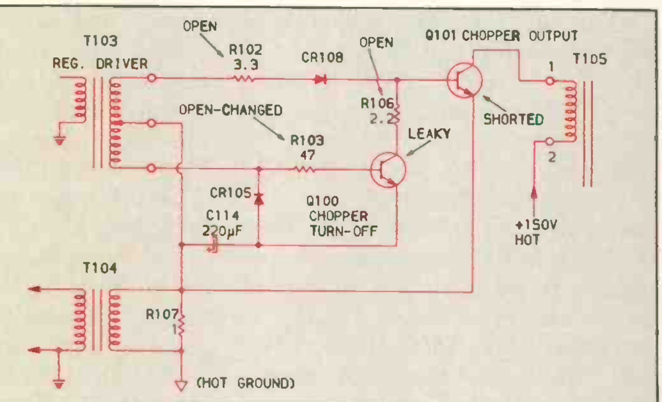


Figure 4. Circuitry between Q101, T103 and Q100 is the center of attention because most of the chopper-component failures occur here. If Q101 is shorted, test R102 and R106. If they are open, the new Q101 installed will be destroyed in a fraction of a second after power is applied.

driver transistor. Following amplification in Q401, the waveform from interstage transformer T103 is applied to the Q101 chopper output's base. Also, Q100 has a function, as explained later. The Q101 chopper collector is connected to the T105 chopper transformer, and the pin 2 end of the T105 winding connects to hot +150V (nearly the only load on the +150V supply).

According to scope waveforms, the theoretically perfect square-cornered dc pulses at the Q101 collector are more like rounded pulses. These rounded pulses pass easily through transformer T105 primary, producing voltages in the four secondary windings. (See Figure 2.) The highest dc voltage is +129V, which supplies the horizontal-driver and horizontal-output transistors with dc power. Also, the +129V is used in the vertical-output stages. A sample of this voltage is provided to the voltage comparator inside U401 for regulation and shutdown in the event of excessive high voltage. This +129V is rectified by diode CR412 and filtered by capacitor C443 (2μF).

The winding between T105 pins 4 and 5 produces +24V after rectification by diode CR415 and filtering by 2,200μF C452. The +24V source powers the audio-output stage and all the remaining sections of the vertical sweep. The winding between pins 3 and 7 produces +16.5V after rectification by CR414 and filtering by 680μF C456. The +16.5V supply furnishes power for most of the signal-processing circuitry, the audio circuits and a few other tasks. Also, by zeners and a voltage regulator transistor, the +16.5V supply is parent to +12V and +11.2V source 1, source 2 and source 3.

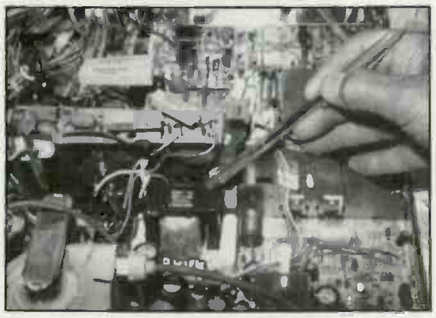
That terminal 3 to 6 winding has the ground at the top, implying that the polarity is reversed, which is correct, because it is feeding a negative supply. After rectification by reversed CR416 and filtering by 220μF reversed C451, −24V is produced. The −24V source is used mostly as a reference for the automatic kinescope-bias circuitry. Evidently, very little current is needed.

Overcurrent shutdown in the CTC131 is much more complicated than it is in most television receivers. Emitter current of the Q101 chopper-output transistor is passed through the primary of transformer T104, with 1Ω resistor R107 paralleling the primary before the current returns to hot ground. The transformer secondary signal is filtered and amplitude-reduced before it joins the part of the circuit that is used for turn-on (when CR426 is low). From there the combined signals go to U401 pin 9. Notice that all the circuits from the secondary of T104 on to pin 9 have cold grounds. When the Q101 current exceeds a certain value, the overcurrent shutdown circuit is activated and the chopper operation ceases.

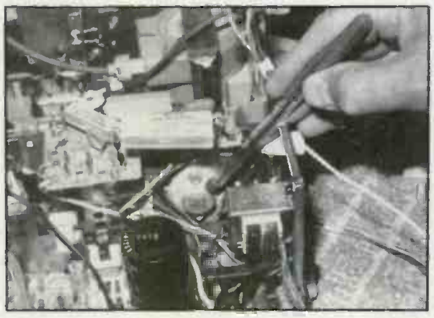
Chopper turn-off operation

Mention was made previously of the turn-off operation. Here's how Q100 operates. (Refer to Figure 2.)

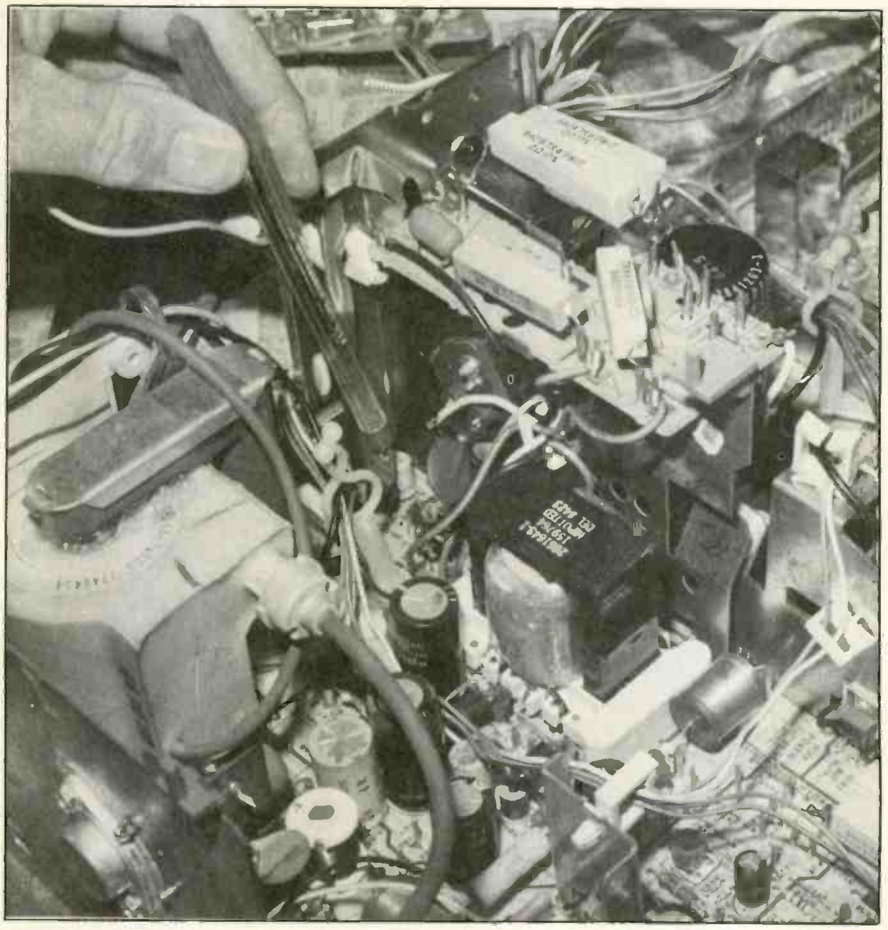
CR108 and 3.3Ω R102 are in series between the Q101 base and



T105, the chopper-output transformer, is pointed out by the end of the pen. Q101 is mounted just to the left and on a vertical panel, with the Q101 terminals and socket side shown.



Q101, the chopper-output transistor (pointed out by the pen), is mounted on a vertical panel, so this is the view from about the center of the chassis. The socket and pins are on the other side.



The chopper turn-off transistor Q100 is located at the end of the pen. Q100 is soldered to the circuit board. All chopper transistors (including Q100) should be replaced only by new ones with original part numbers.

the top terminal of T103's secondary winding. When that top terminal is positive, CR108 will conduct through R102 and present a turn-on current to the Q101 base.

At the same time, an instantaneous negative voltage from the bottom terminal forces CR105 to conduct, and this charges 220μF C114 with about -2V relative to the Q101 emitter. (Notice that the positive lead of C114 connects to Q101's emitter.)

When polarity of the input/drive voltage reverses, diode CR108 conduction is turned off, and the polarity of the bottom terminal forces the emitter/base junction of Q100 to become forward biased. Therefore, Q100 saturates, producing reverse current flow through R106, which removes the stored charge in the emitter/base junction of Q101 to make certain that the Q101 transistor current turns off quickly.

If the receiver is operated when the Q101 chopper has a problem in the Q100 area, Q101 will heat up excessively. Above a certain overload point, the transistor will short and the 5A fuse (F100) will be blown. Unfortunately, by this time several components are likely to have been damaged. The critical ones are: R106, R102, R103 and CR108, plus transistor Q100 chopper turn-off. Of course, the Q101 chopper transistor carries the largest load and is subject to external overloads that cause Q101 to short.

Common symptoms

If the symptoms are no picture/no raster, measure for the +129V collector voltage at the body of the horizontal-output transistor. This shows whether or not the chopper power-supply circuits from T105 are normal. If zero (or very low) dc voltage is measured at the horizontal output, test the Q101 chopper-output transistor collector voltage at the case.

(Remember, the negative test probe must be touching the hot negative terminal. The correct voltage is hot +150V, but if the chopper case checks zero volts, or much lower than +150V, test the four diodes of the bridge rectifier. A convenient hot ground for these tests is the negative terminal of C105. Notice that the +150V tests to hot ground, but the +129V supply tests to cold ground. Specific tests for the bridge diodes are supplied later, along with additional schematics. And of course, the four basic dc voltages produced by rectification of T105 pulses can serve as checkpoints where a few minutes spent in testing can produce at least four voltages for analysis. These checkpoints are: TP400, TP401, TP402 and TP404. (See Figure 2.)

Figure 3 shows such major components as the bridge rectifiers, the F100 fuse, and the R109 surge-limiting resistor. The fuse and resistor usually must be replaced any time a shorted Q101 chopper-output transistor is replaced.

Of course, both the fuse and limiting resistor are there for protection (although the resistor has other functions). Therefore a list of combined symptoms can be helpful. For example:

- Sometimes when the chopper transistor is only leaky, the fuse will not blow.
- A shorted Q101 chopper output and a shorted horizontal-output transistor occurring at the same time will blow the fuse and R109.
- Usually both the fuse and R109 will be opened by overload from a shorted or leaky bridge diode, or a shorted Q404 horizontal-output transistor along with a shorted flyback transformer.

A low-resistance reading across filter capacitor C105 in the +150V hot source often indicates a shorted Q101 chopper transistor. Measure the resistance from the body of Q101 to chassis ground (and also hot ground). Then remove the chopper Q101 output transistor from the circuit and make the same measurement again. If the second reading is much higher, this could indicate leakage in Q101. Next, test Q101.

Continued after case histories.

Dead television—no panel lights

In this CTC131 RCA, the chassis was completely dead. None of the LED indicators on the front panel could be lighted. I measured the dc voltage at the horizontal-output transistor's case or collector, and then tested the voltage at the chopper-output's collector. Both readings indicated a low-voltage problem. F100 was blown, but when it was replaced and the receiver was turned on the second time, it blew again. I removed the Q101 chopper-output transistor from the circuit and found leakage between all three elements.

No B+ was measured at the Q101 chopper collector after it was replaced. A B+150 hot should be there at all times when Q101 is out of the circuit. An ac voltage measurement across the bridge rectifiers indicated an open circuit that was eliminating the 120Vac power. R109, a 2.7Ω 15W resistor, tested open in the ac circuit. (See Figure 3.) Replacement of the F100 fuse, R109 and the Q101 chopper-output transistor brought the receiver to life and solved another chopper problem.

Incidentally, R109 should never be replaced with a large-wattage resistor that has a resistance of less than 2Ω. Not only is the resistance critical, but the resistor construction must be right for self-destruction when the current is exceeded. A normal resistor does not fit the specifications and would leave the television without proper protection. R109 is connected to lugs of the degaussing board.

Chopper destroyed repeatedly

Symptoms of the CTC132 chassis were a front indicator light that came on, then the raster bloomed large and everything (picture and sound) went dead. The 5A F100 and Q101 were replaced, but the operation was the same after power was again applied. This time, the replacement Q101 had a low-resistance short between collector and emitter terminals. Q101 can be checked for leakage and shorts in-circuit by using the Q101 case for the positive and C105 hot lead for the ground. A low-resistance reading under 1Ω across filter capacitor C105 indicates a shorted Q101 chopper-output transistor.

To prevent ruining several chopper transistors, use a variable transformer for the receiver's line voltage. Start with a low line voltage, perhaps 35Vac. Slowly increase the line voltage as you monitor the low voltage at the Q101 chopper-output transistor's collector. If the chopper circuit is defective, the transistor voltage will remain low and the Q101 chopper transistor will operate warmly as the ac voltage is increased.

Check out all components in the base circuit of Q101 before suspecting overloaded secondary transformer problems. Overloads in the T105 transformer circuits will usually cause some overheating in Q101 chopper, but excessive overloads will destroy the Q101 transistor.

The Q100 chopper turn-off transistor was tested

Circle (21) on Reply Card

Circle (22) on Reply Card

in-circuit and was found to be leaky between all three pins. This transistor is soldered directly to the large circuit board. The chassis must be moved back to the servicing position, so the connecting cables must be loosened where provided.

After replacement of Q101, Q100 and F100 (5A), the low voltage was restored along with the TV performance.

Q100 and Q101 destroyed

In another CTC131-chassis receiver, the raster appeared along with normal sound, but only for a few seconds. Then all functions went dead, including the panel light. F100 was not blown, but there was no voltage at the collector of the chopper-output transistor. The Q101 chopper was replaced, but went out immediately. Next, the Q100 chopper turn-off transistor and Q101 were replaced at the same time, but with the same results—both transistors were destroyed. Each transistor tested leakages or shorts between all of its elements.

Attention shifted to the Q401 chopper-driver transistor. It and all diodes in the input circuit of Q101 were tested, but were normal. All windings of transformers T103 and T104 were tested for correct resistance. Finally, the Q101 base resistors were checked and found to be open. These resistors were 2.2Ω R106 and 47Ω R103. Remember the values and the circuits because these are typical troubles. (See Figure 4.)

After replacement of Q100, Q101, R106 and R103, the line voltage was reduced to about 35Vac and slowly increased until the chassis started to work at 120Vac.

As noted previously, the most frequent component failure is the Q101 chopper-output transistor. Q100, the chopper turn-off transistor, has many failures, some that might have visible symptoms. Q100 in this machine was blown apart and, of course, had open base and collector pins. Other components that fail often are R106, R102, R103 and sometimes CR108.

Deflection problems—Q101 destroyed

Suspect problems in the horizontal-output circuits when the Q101 chopper and Q404 horizontal-output transistors are tested and found to be shorted. Replace both transistors, but use the variable line-voltage transformer to slowly increase the input ac voltage from 35Vac. When the line voltage is increased slowly up to about 60Vac, the chopper-output voltage of +129V (at 120Vac) might be expected to rise to about +65V at 60Vac. If the chopper-output voltage rises only to about +4V, turn off the power and feel the cases of both transistors. If both transistors feel warm, they are overloaded, and the search will have to be continued.

At this time it is appropriate to consider some possible trouble areas. Insufficient drive waveform or the + 16.5V source at U400 horizontal IC can cause the horizontal-output transistor to draw excessive current. A T401 flyback with shorted windings or a shorted component in the output circuits of Q404 might damage both the Q404 horizontal-output transistor and the Q101 chopper-output transistor.

Several CTC131 chassis developed leakage in capacitor C438 (of the horizontal-output stage), which ruined both horizontal- and chopper-output transistors. Replace the capacitor with the 161372 original part number or a substitute of *precise* capacitance and 1,200V rating.

In one chassis, both C438 and the flyback had leakage. It is possible to find a shorted Q100, Q101, Q404, U400 and flyback in addition to a very leaky C438 capacitor.

Unusual locking problem

After a half hour of operation, the picture would begin to *pull* and *tear* horizontally. At first, the pulling could virtually be eliminated by increasing the brightness and contrast. However, when a dark screen appeared, the picture would pull and become unstable. After the set had operated for two hours, the picture showed excessive pulling at all times regardless of the brightness and contrast levels.

After removing the back cover, I found that someone had previously replaced the Q404 horizontal-output transistor and the chopper turn-off transistor Q100. The Q100 chopper-turn-off transistor had been replaced with a different type of transistor. Replacing Q100 again with the correct part number 142251 solved the picture pulling problem completely.

Because there are many cables and controls connected to the RCA CTC131-132 chassis, try to service it while the chassis is in the cabinet, if possible. Move the chassis to the rear in the servicing position to provide more room.

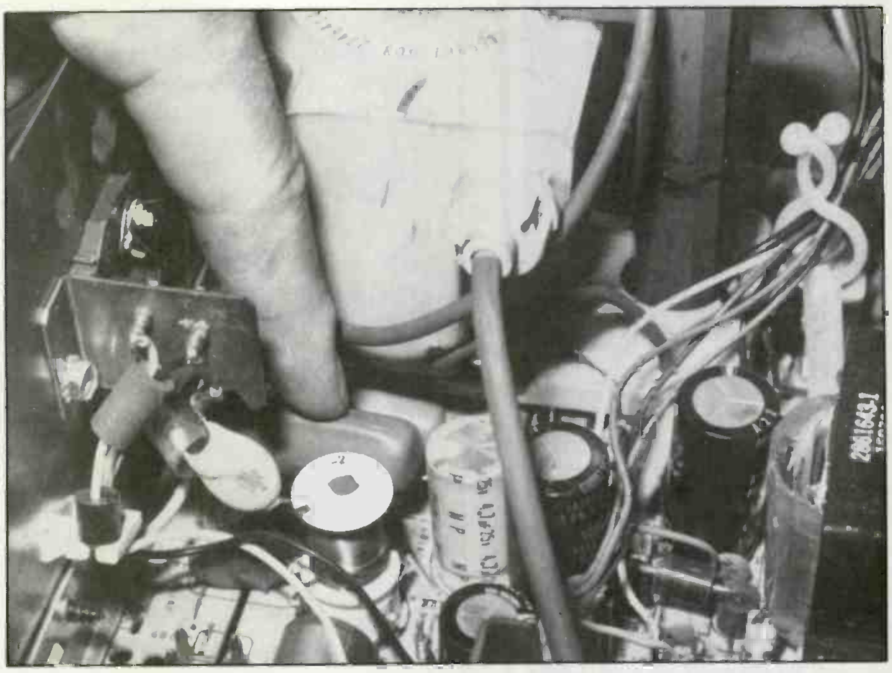
Technicians who have studied the CTC131 circuits extensively and have serviced many of them might find the explanations and test techniques to be rather simple. However, I have tried to adapt the CTC131 tests to the tests and techniques that have been found useful for rapid servicing of TV receivers that are two to five years old.

Problems in the CTC131 are often solved by replacement of the Q101 chopper-output transistor, the R102 resistor and the R106 resistor. Sometimes a new Q100 chopper-turn-off transistor is required. Replacement of these few components repairs an amazing percentage of the dead receivers.

Continued from page 25.

A diode tester or the diode function of a digital multimeter can be used to test individually each silicon diode of the bridge. In addition to the usual hazards of large-current diodes, these diodes might be damaged by weak lightning strikes or strong overloads (such as a shorted Q101 or horizontal-output transistor). These bridge diodes could become shorted or just leaky.

For an accurate test of diode leakage, disconnect one lead of the diode during the tests. If the DMM gives any hint of leakage, change to a VOM on a higher-resistance range. This reverse-polarity leakage-resistance reading should be very high for these diodes. If there is doubt about a diode, replace it. Use 3A rating diodes for replacement. (Incidentally, if the RCA 2.7Ω 15W R109 resistor cannot be obtained, replace it with two paralleled 5Ω 15W resistors. However, the genuine article is recommended.)



C438 (which the technician is pointing to) is a part of the horizontal-output circuit. When C438 is shorted or severely leaky, it might destroy Q100, Q101, Q404 and U400.

Finding the components

Here are the locations of these input ac circuit components: R109 is mounted high on the degaussing board; fuse F100 is plugged into snap clips near the back at about the center of the chassis (easy access); the large C105 filter capacitor is near the right-to-left center and about 25% from the rear of the chassis; and the bridge diodes are scattered in a "southeast" direction on the circuit board near C105.

If the +150V hot supply at the Q101 collector measures almost zero voltage (compared to hot ground), but the four bridge diodes have been tested and finally replaced with new ones without improvement, then where do you look? Few components remain untested.

Assuming that you have tested C105, two items remain untested: continuity of the power wiring and the actual 120Vac line voltage. Figure 3 shows all the basic ac wiring except the noise filter, L102. Unplug the power and check the power wiring with an ohmmeter. Then, reconnect the power and check for 120Vac using the DMM ac function. The 120Vac *must* reach CR100 and CR101 cathodes where the voltage can be measured.

When the fuse continues to blow

If you've done everything you can think of to repair the set, but the fuse blows every time you turn the set on anyway, here's how to protect the fuse and the TV circuitry while you probe further. Remove the fuse from its holder and connect a 100W incandescent light bulb in its place. The resistance of the bulb limits the current that the television can draw to a safe level, while its brightness gives you a visual indication of the amount of current being drawn: If the bulb is bright, the television is drawing high current; a dim bulb means the current draw is low.

In one CTC131 I encountered, the first test with the bulb/fuse showed a bright bulb. I removed the horizontal-output transistor mounting screws (to disconnect the B+) and the light became very dim. These symptoms pointed to serious problems in the high-voltage and deflection sections.

If the test just described results in a bright bulb during both conditions, the next step is to remove chopper-output transistor Q101. If the bulb then becomes dim, Q101 is shorted or something is drawing excessive current from one of the four T105 voltage supplies.

If the bulb remains bright and no obvious defects are found, the next step is to check all four bridge diodes; DMM and VOM tests of the diodes were described earlier. Certain types of diode leakage vary with the applied voltage. Therefore, a VOM often would show a leakage reading where a DMM would not. An initial test of the diodes can be made in-circuit (without disconnecting any leads). Of course, replace any diodes that show leakage.

Also, check the resistance of C105; it might be shorted or leaky (notice the hot ground).

Problems in T105 voltage supplies

In addition to defects in the chopper driver and output stages, it is possible for problems in one or more of the four dc supplies powered by T105 to develop from shorted, leaky or open diode rectifiers or filter capacitors. If the overload is heavy enough, it can cause chopper shutdown.

Check the silicon rectifier of each voltage source. This can be done rapidly with the diode test of a DMM. Normal readings for CR413 and CR415 are about 0.458V with overrange readings displayed for the other polarity.

When CR414 is given the diode test, the result might be 0.430V in one direction and 0.650V in the other direction. These test results are normal, because the +12V regulator provides a low-resistance path in one direciton. If there is doubt, disconnect one end of each diode and test the diode as if it is out of circuit.

Resistance readings for tests

Shorted or leaky components in circuits connected to different voltage sources can cause the chopper power supply to shut down or drastically reduce the output voltages. After you've tested the major components of the power supply, take a few ohmmeter readings of the resistances of the various voltage supplies to cold ground. You might discover

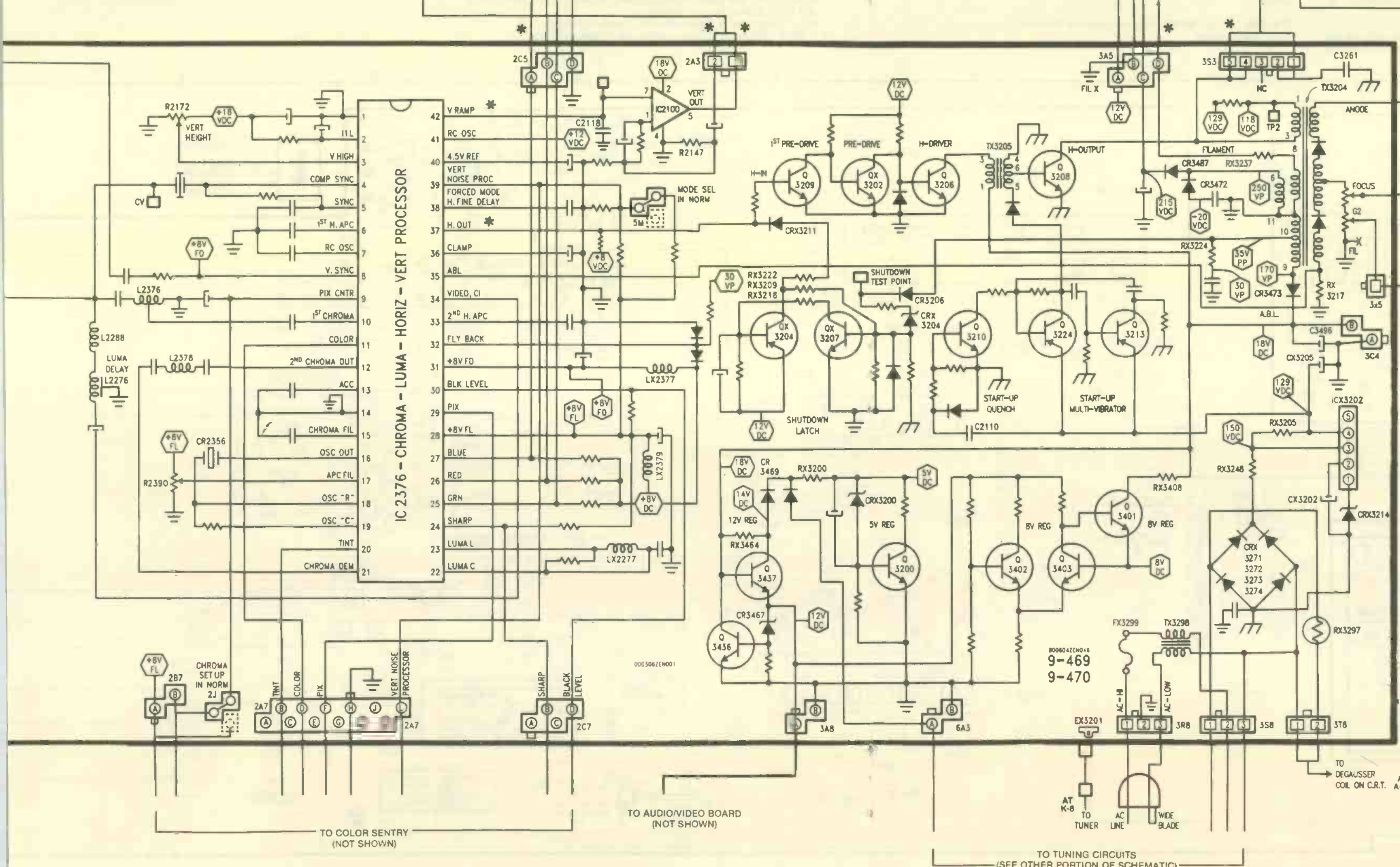
Continued on page 39.

3016

PROFAX ES&T Manufacturers schematics

Zenith
SD2097S
chassis
color TV
receiver

December 1987



SD2097S SERVICE SYSTEM SCHEMATIC

Product safety should be considered when component replacement is made in any area of a receiver. The shaded areas of the schematic diagram designate the components in which safety is of special significance. It is recommended that only exact cataloged parts be used for replacement of these components.

Use of substitute parts that do not have the same safety characteristics as recommended in factory service information may create shock, fire, excessive x-radiation or other hazards.

This schematic is for the use of qualified technicians only. This instrument contains no user-servicable parts.

The other portions of this schematic may be found on other Profax pages.

PROFAX

ES&T Manufacturers' schematics

CT0911 BASIC CIRCUIT DIAGRAM

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CT0911 BASIC CIRCUIT DIAGRAM

ES&T Manufacturers' schematics

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3015

Hitachi
CT0911
chassis
color TV

December 1987

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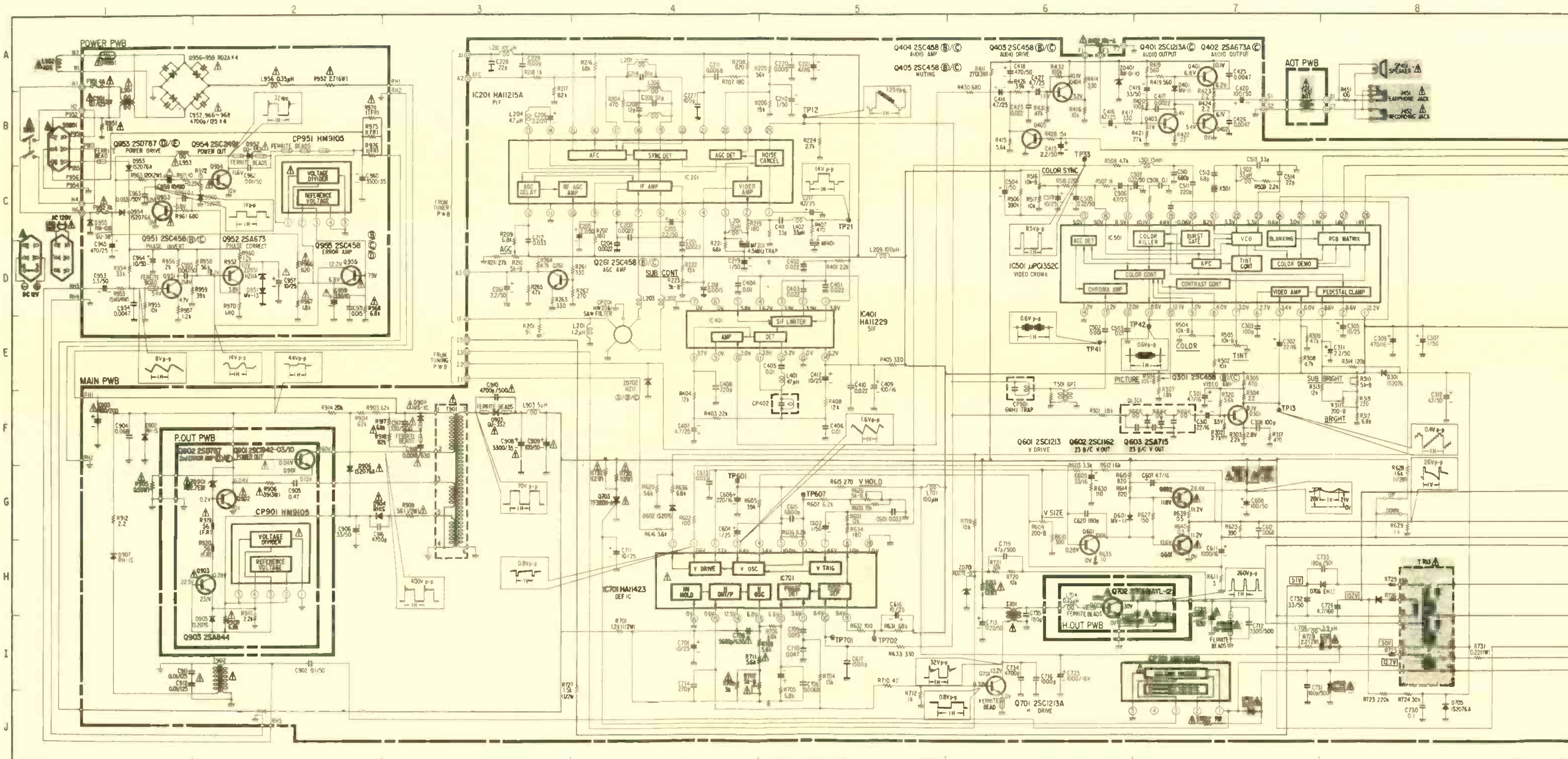
- Because this is a basic circuit diagram, the value of the parts is subject to be altered for improvement.
- All dc voltage to be measured with a tester (100kΩ/V).
- If R974, R975 or R976 opens, replace all three resistors.



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SD2097S SERVICE SYSTEM SCHEMATIC

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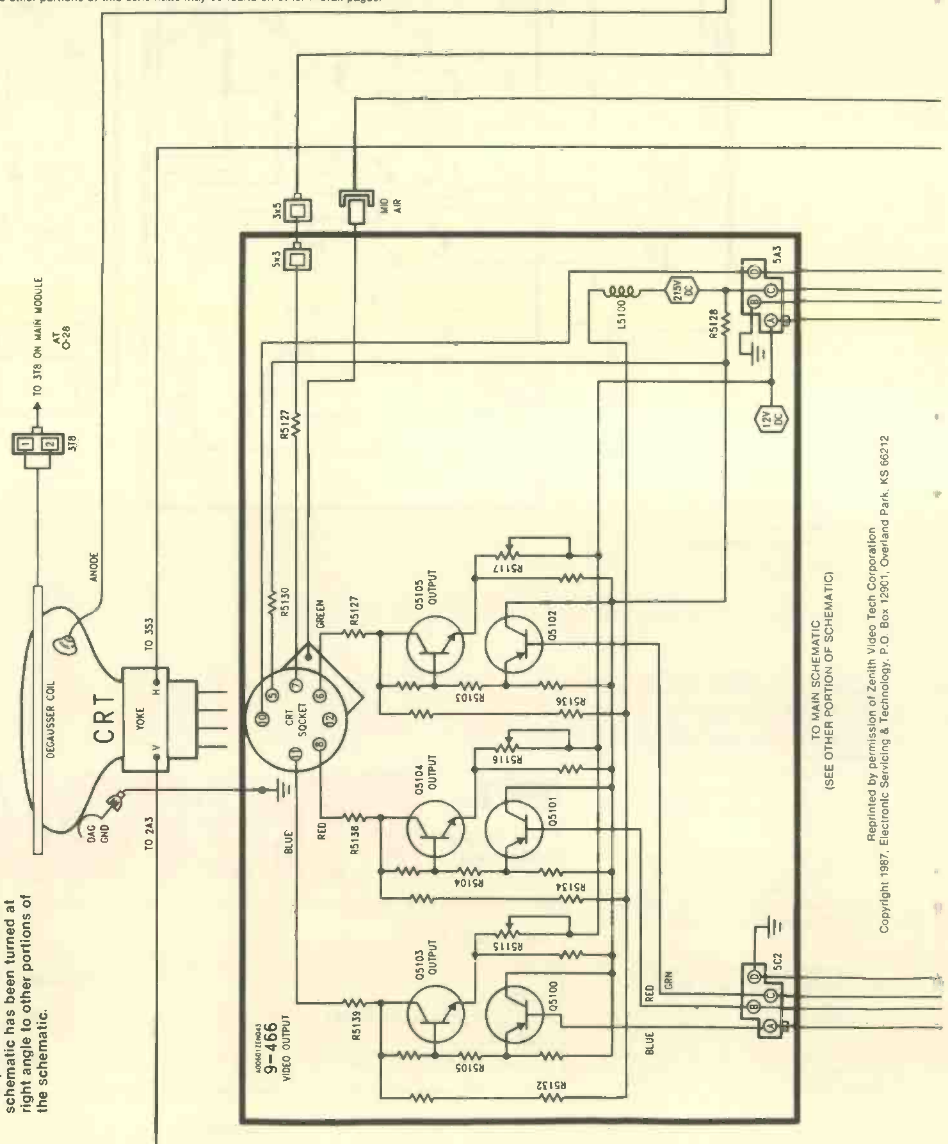

This portion of the SD2097S schematic has been turned at right angle to other portions of the schematic.

ES&T Manufacturers' schematics PROFAX 3016

SD2097S SERVICE SYSTEM SCHEMATIC

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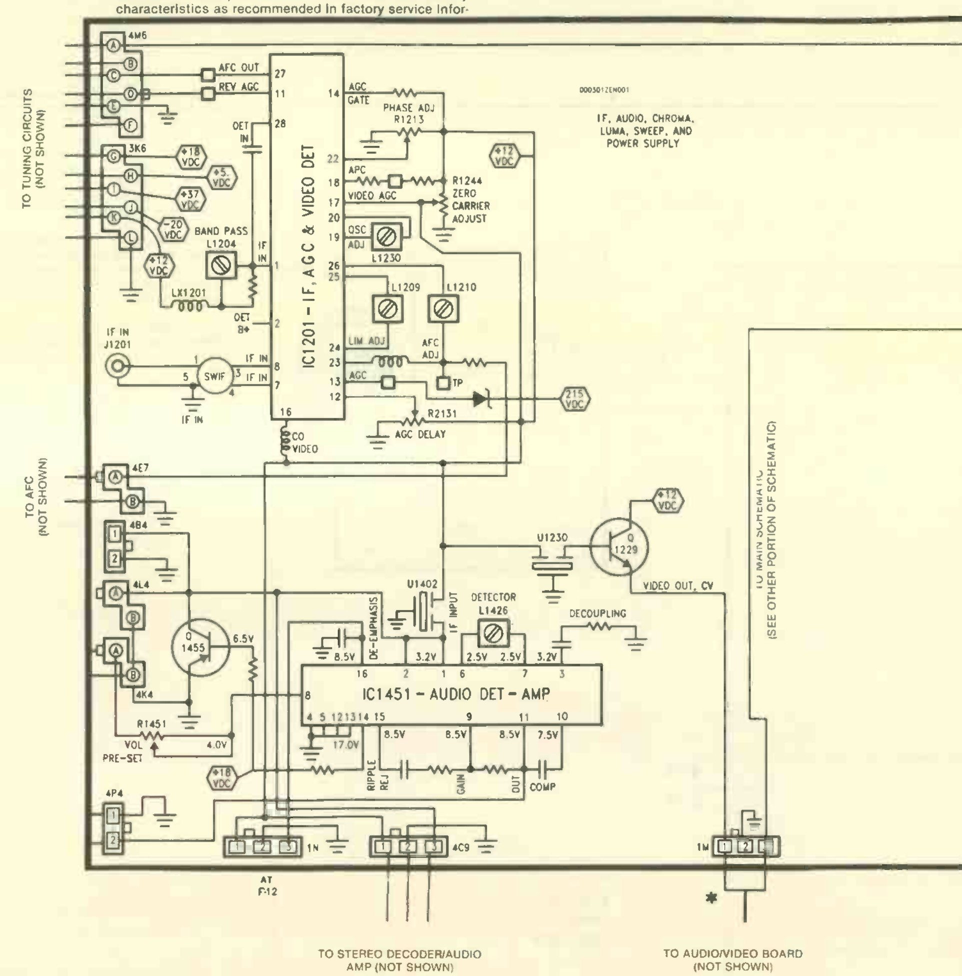
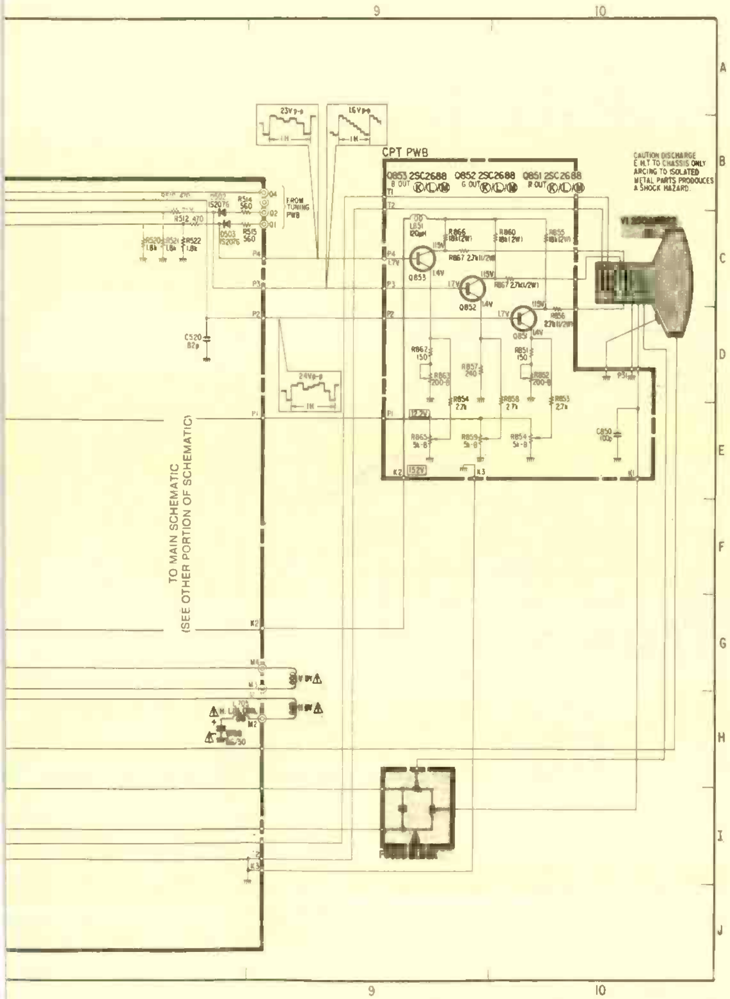


CT0911 BASIC CIRCUIT DIAGRAM



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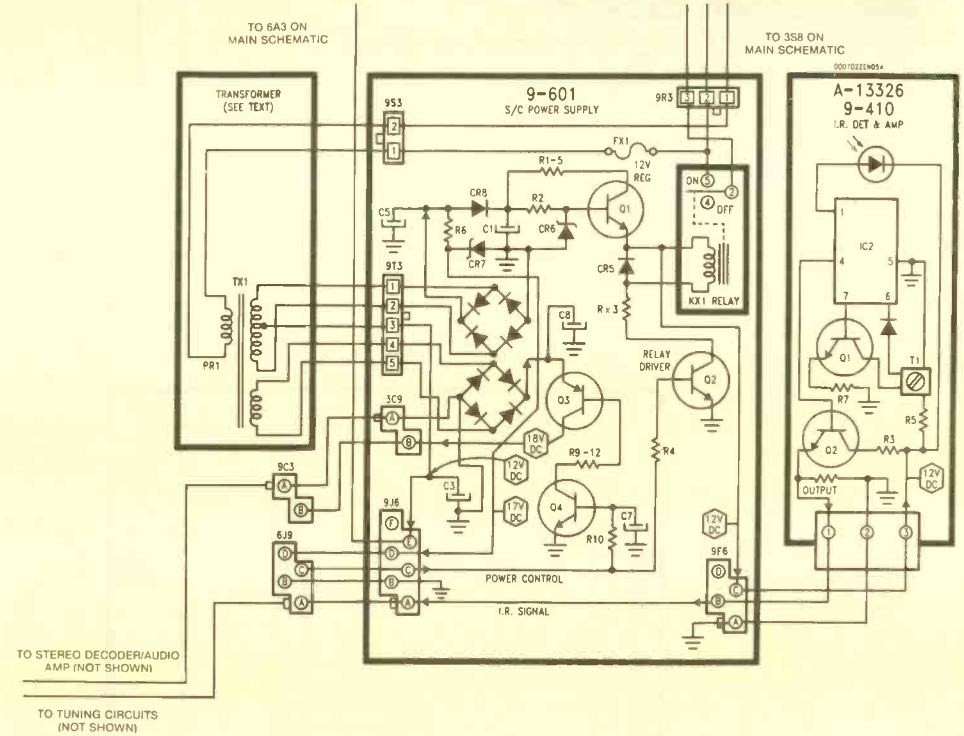
SD2097S SERVICE SYSTEM SCHEMATIC



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ES&T Manufacturers' schematics PROFAX

December 1987

Table 1.
Primary- and secondary-winding resistance readings

Transformer	Primary resistance	Secondary resistance
T103 driver	1.8Ω	2.8Ω CT
T104 shut-down	0.19Ω	0.33Ω
T105 output	0.35Ω	0.33Ω for pins 4 to 8
T401 horiz. output	0.98Ω	0.13Ω from pin 2 to pin 7

Table 2.
Normal resistances from test points to cold ground

Voltage source	Test point	Source	Resistance to cold ground
+129V	TP400	CR413	Above 10kΩ
+24V	TP402	CR415	Above 1,200Ω
+16.5V	TP401	CR414	Above 425Ω
+12V	TP310	Q303 emitter	Above 400Ω
+11.2V	TP308	CR302	Above 385Ω
−24V	TP404	−CR416	Above 1,800Ω

Continued from page 30.

leaky components in the branch power supplies.

The resistances shown in Table 1 were obtained by a digital multimeter from the test points mentioned. Of course, the other lead of the DMM was attached to cold ground. The readings must all be made with the receiver off.

Any reading of lower resistance than those found in Table 1 might indicate a leaky or otherwise defective component that is connected to the same voltage source. These measurements can be taken from the various test points or from the corresponding diode rectifier. Although these readings might be different depending on the type of meter used, this voltage source-to-ground resistance table could save you valuable time when the chassis is intermittent or overloaded.

During troubleshooting, you must know the dc resistance of various windings. That helpful data is supplied in Table 2.

Circle (27) on Reply Card

Computer-aided circuit design

By Howard Falk

When you're designing a circuit, after you sketch it out your next steps are probably to make a few rough calculations, then start to build a breadboard. When the components are connected and the power is turned on, you get your first look at what has to be changed to actually make the circuit work.

If you have a personal computer, however, there may be a shortcut that can take you directly from your sketch to a reliable, working circuit. With inexpensive circuit design software, you can type in descriptions of the components you are using and the way they are connected to one another. The software will then calculate the performance you can expect from your circuit. If it does not meet expectations, you can do additional computer runs, changing component values until you get the desired results.

You don't have to write any computer programs to get these results. What you must do is learn to use one of the commercial computer-design software packages that are currently available. That will take some time and effort, but it is well within the grasp of anyone who can put together a working electronic circuit.

This is an adaptation of an article by Falk, a free-lance writer and former electronics magazine editor who has published several books and articles about using personal computers.

Simulated circuits

If you think software packages that sell at reasonable prices have only trivial capabilities, think again. These packages typically can handle circuits with 30, 40 or more nodes. (A node is simply a connection point for two or more components.)

Take a look at the 16-node ratio multiplier circuit shown in Figure 1. It includes eight transistors, two diodes and an operational amplifier. A program with a 30-node capacity can handle circuits approximately twice as complex as this one.

The calculated results these packages will produce include dc circuit parameters such as voltages, currents and power for all components or for selected components. These results allow users to determine immediately needed power and voltage ratings for components, as well as power supply requirements.

Packages designed to simulate ac performance go further. For instance, with ACIRC, offered by FB Circuit Products, the signal (sweep) input to the circuit being simulated can be specified by an initial and final frequency, an initial frequency step, and a multiplier that selects linear or logarithmic sweep. To excite the circuit with a single frequency, the user simply sets the initial and final frequencies to the desired value. The package then calculates results such as voltages, phase angles and gains at nodes or across branches.

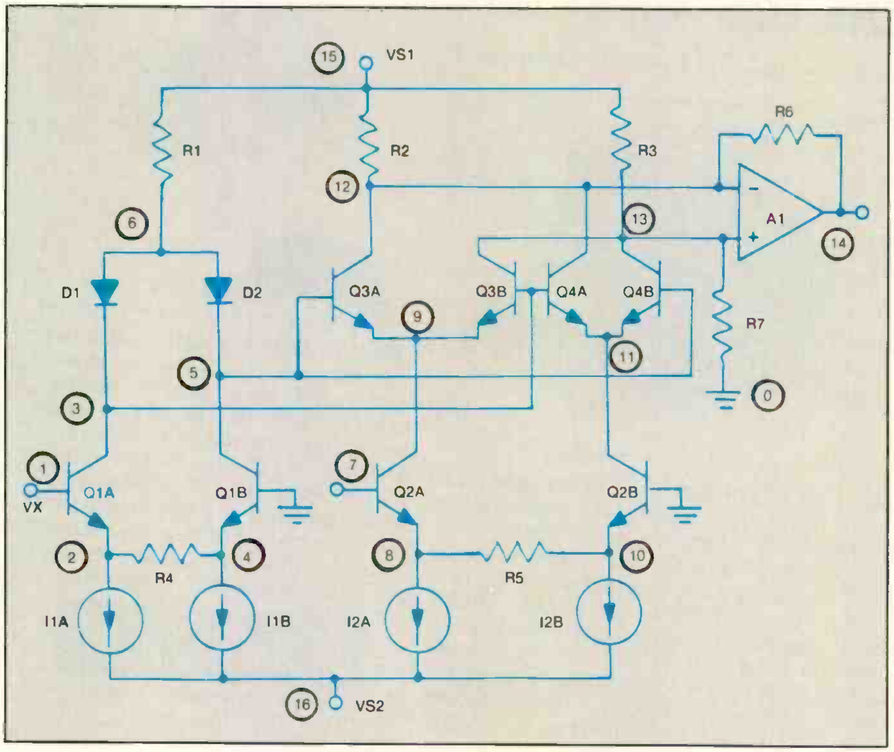


Figure 1. This ratio multiplier circuit, simulated by the ACIRC package, has 16 nodes (see circled numbers). Each of the input code lines that describe the circuit for ACIRC contains information on node connections and operating parameters for one of the components.

Don't expect instantaneous answers from these circuit-design packages. The computations they go through are often very complex and lengthy. Results for a typical 40-node circuit calculated by the ACAP package will take an IBM personal computer a full 40 minutes to complete.

Components on tap

Circuit-simulation packages recognize and use only certain types of components. All the simulation packages make available passive components such as resistors, capacitors and inductors, and all allow use of voltage or current sources, or both. The ACIRC package also provides for use of transformers in circuits.

In addition to limits on the number of nodes a package will handle, there may also be specific limits on the number of each specific type of component that can be used. Users of the DCNAP software package from BV Engineering are limited to no more than 70 resistors, 30 inductors, 30 capacitors, 20 voltage sources, 20 independent current sources and 30 dependent current sources. The total of all components in a circuit simulated by DCNAP must not exceed 200. The numbers differ for other packages, but most of them also have their component limits.

With some of the packages, like ACAP (from DYNACOMP), DCNAP and ACNAP (from BV Engineering), users have to construct their own models of transistors and other active devices using combinations of the circuit elements the package recognizes. (See Figure 2.) The ACAP manual shows suggested models for op-amps. (See Figure 3.)

Other packages come with active device models that can be called from storage and inserted into circuits as components. For example, the DCIRC and ACIRC packages (both from Circuit Products) come with simple models of transistors, FETs and op-amps.

The CircuitPro package (from E/Z Cad) analyzes circuits with as many as 120 to 150 transistors and comes with ready-to-use models for 48 industry-standard diodes, 35 bipolar transistors and seven types of operational amplifiers. The models are quite realistic. For example, the op-amp models include almost all the first- and second-order characteristics found in real-world amplifiers. (See Figure 4.)

Users can also define their own

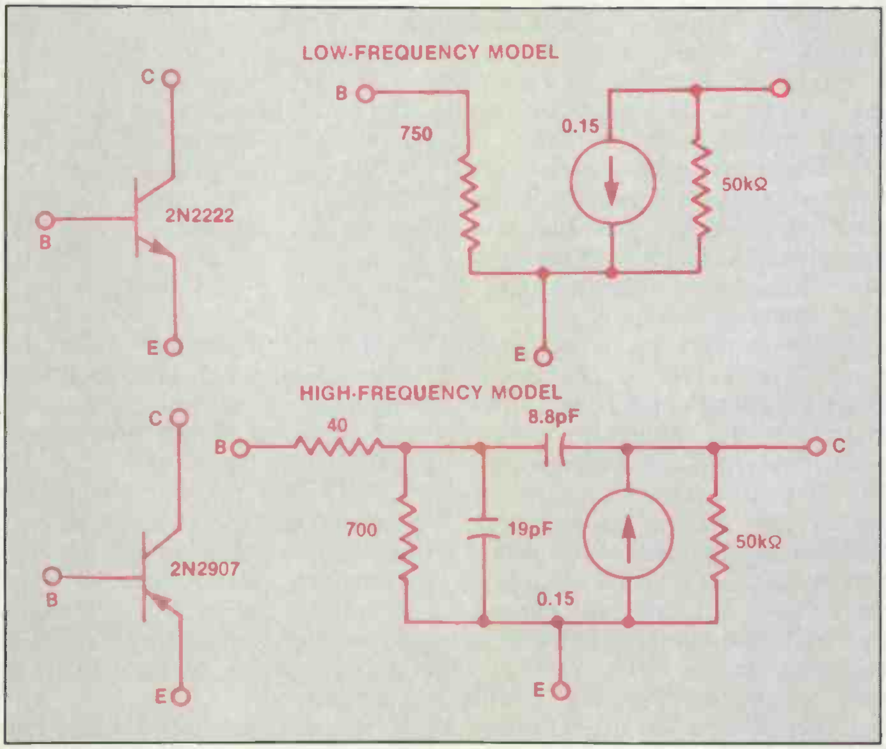


Figure 2. Low- and high-frequency transistor models must be made up of components recognized by the ACNAP package.

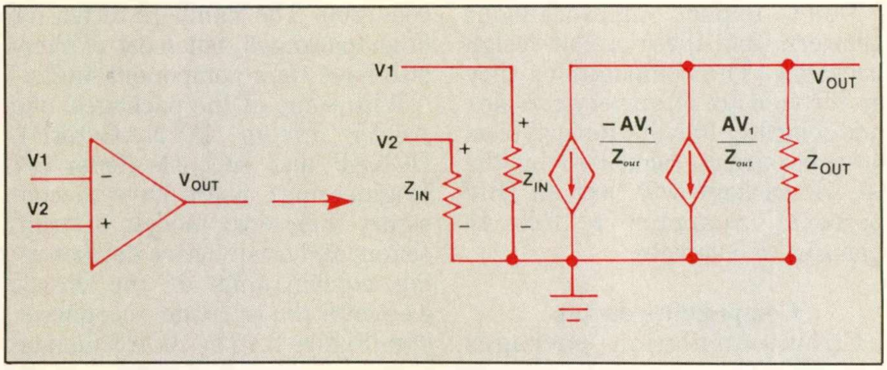


Figure 3. The manual for the ACAP package recommends this model for op-amps. Models such as these are created by the user. Here resistor and current-source components are calculated and specified by the user. The quantity A is the gain of the op-amp.

models for other devices and list them as sub-circuits, which can then be used, by name, as standard elements whenever needed. Most elements also have model parameters that can be used to define the shape of their characteristic curves.

Checking worst-case scenarios

An important feature, offered by many of the packages, is simulation of the kinds of variations that can be expected in components. When a circuit is built, component values will be defined within tolerance ranges. A 5,000Ω resistor with a 20% tolerance may actually have a resistance anywhere between 4,000Ω and 6,000Ω.

The ACAP package takes a simple approach. It calculates the mean and standard deviation of selected node voltages, based on the component tolerances. These statistical results give the user some idea of the limits of performance that can be expected due to component variations.

Another approach is to allow users to simulate the changes in output that will result from a small change in the value of a component. The ACNAP package uses this kind of sensitivity analysis to reveal the amount by which the magnitude and phase of the output will be affected by a 1% change in the value of any component. ACNAP also has a Monte Carlo analysis feature that randomly varies component values within their specified tolerances. Results indicate the statistical limits of the circuit responses.

Such calculations can be extremely valuable, particularly when many copies of a circuit will be fabricated. However, users must be prepared to wait patiently while the software threads its way through the computational complexities. DCNAP, which has sensitivity and worst-case analysis capabilities similar to those of ACNAP, ran a typical sensitivity analysis for a 4-node circuit in 107 seconds. A worst-case analysis for the same circuit took 81 seconds. Obviously, run times for analyses of larger circuits will be much longer. With ACAP, it may take 10 or more iterations of the statistical calculations to get accurate results.

Extras and errors

Some of the packages have important extra features. For example, the ACNAP package uses the desired frequency range and the number of integration steps to calculate the noise equivalent bandwidth. (See Figure 5.) ACNAP can also produce a file that allows computation of the circuit's time-domain response, although the file has to be processed by a separate signal processing package from the vendor.

The DCIRC package caters to users who want to accurately fine-tune output based on component parameters. (See Figure 6.) The user adjusts the parameters, then gets a rapid display of output results on which to base further adjustments.

Users will inevitably make errors as they try to get these packages to solve circuit-design

```
SECOND-ORDER BANDPASS BIQUAD
*
*   OP AMP MACRO MODEL
*
.SUBCKT   AMP   1   2   3   4
GAMP   3   4   1   2   1K
ROUT   3   4   100
CPOLE   3   4   16U
.ENDS
*
*   BIQUAD
*
R1   1   2   1.6K
R2   2   3   1.6K
C2   2   3   0.1μF
R3   2   4   160
R4   3   5   160
R5   5   6   160
R6   6   7   160
C6   7   4   0.1μF
XOA1   2   0   3   0   AMP
XOA2   5   0   6   0   AMP
XOA3   7   0   4   0   AMP
*
*   INPUT SOURCE
*
VIN   1   0   AC   1
*
*   CONTROL STATEMENTS
*
.AC   LIN   100   5K   25K
.PLOT   AC   VDB (6)   VP (6)
.PRINT   AC   VDB (6)   VP (6)
.END
```

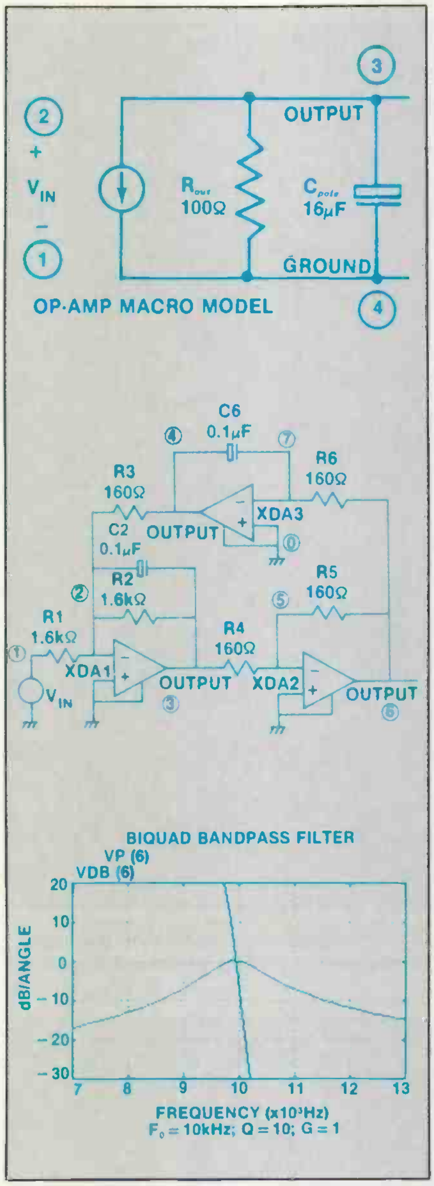


Figure 4. Input statements to describe and simulate a bandpass filter circuit with the CircuitPro package are shown above. At the top right is an "op-amp macro model" that is used three times in this circuit. The circuit itself, with node numbers circled, is shown at the right center. At the bottom right is the output for gain and phase from 7,000Hz to 13,000Hz, as plotted by CircuitPro.

problems. Unfortunately, most of the packages do not provide convenient ways to handle and correct such errors. Some provide no error messages at all; others, like DCNAP, make some effort to do so. DCNAP is designed to recognize certain errors, such as numbers, components or nodes that are called for but do not exist in the circuit description. If the user makes one of these errors, the package will display the warning "ILLEGAL ENTRY, please try again." When other errors such as running out of disk storage space occur, the package is not so lenient, and the user has to start all over from the beginning of the program sequence.

In ACNAP, error messages are 2-digit numbers; the user refers to a list in the manual to interpret them. In some cases the package simply refuses incorrect input and returns the user to the previous program step. However, the vendor promises to clear up, over the phone, any error situations the user cannot understand.

Finding the right package

Most of the effort a user will put into one of these circuit simulation packages will be in the form of keyboarding circuit descriptions. In the long run, packages with convenient data input facilities are the ones that will be easiest to use.

Input data may be entered one line at a time or may be in the form of an entire input file that users prepare with their own editing or word processing software. In either case, users will have to learn the exact formats that are to be

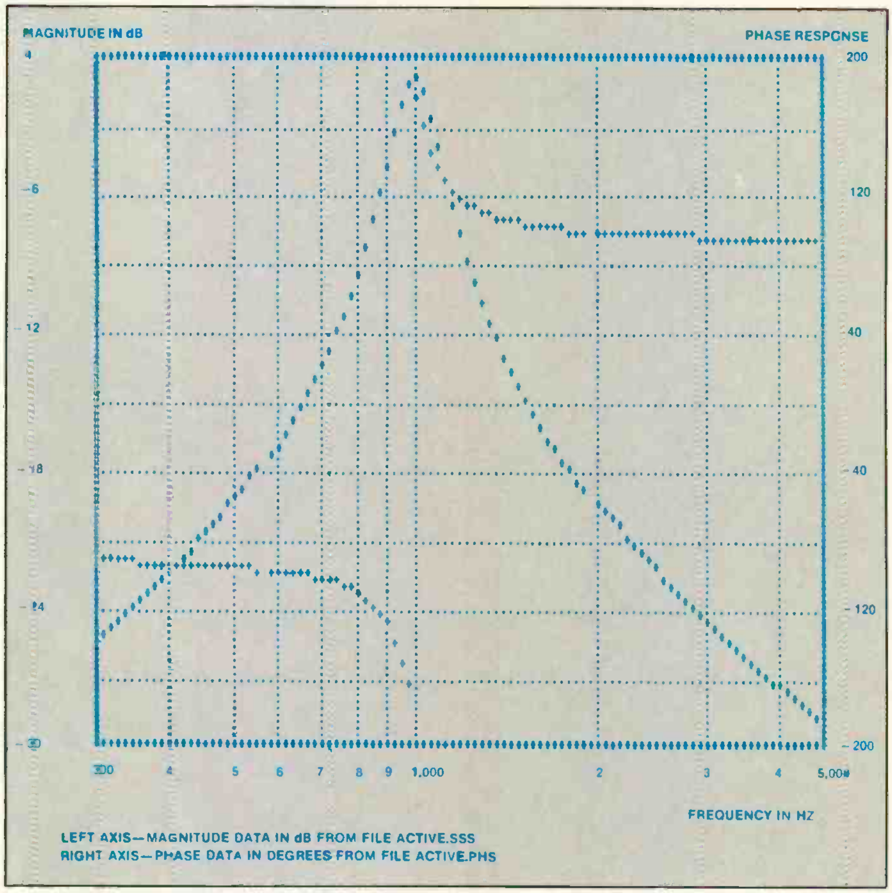


Figure 5. This bode plot for a bandpass amplifier, produced by the ACNAP package, shows the magnitude and phase response of the circuit over a defined frequency range.

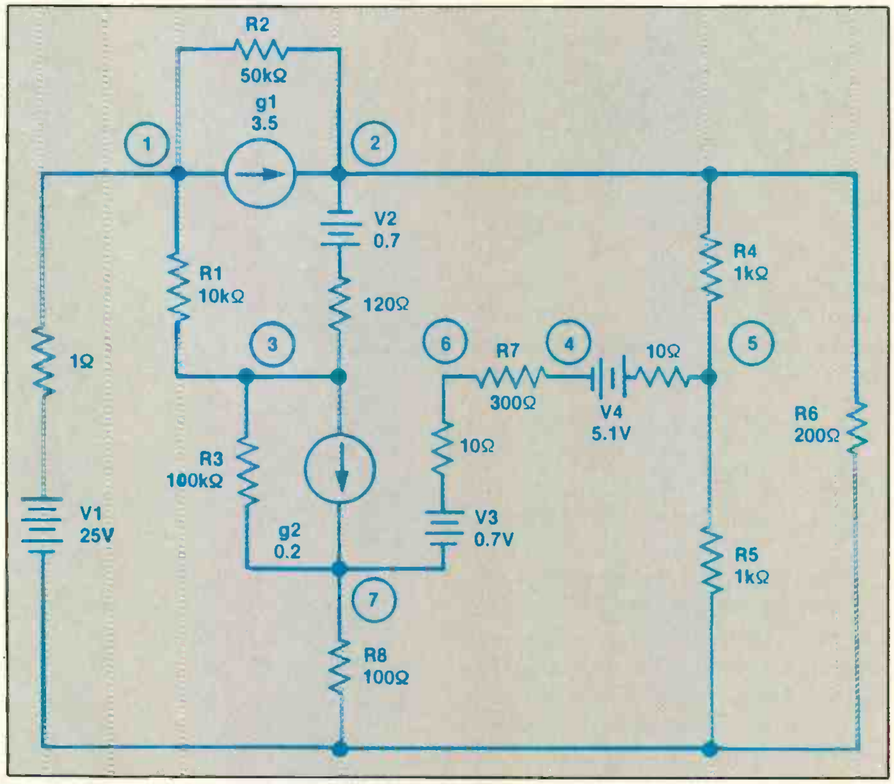


Figure 6. This voltage regulator circuit, laid out for simulation by the DCNAP package, uses the two dependent current sources, R2, V2, R3, V3 and the 120Ω and 10Ω resistors to model two transistors. Nodes are shown as circled numbers. For this package, the ground node is always numbered 0.

used, including the order and manner in which component names, types, node-connections and other items have to be entered.

If the data is keyed in wrong or the circuits need to be revised, the input may have to be changed, sometimes while it is being entered, often after a complete set of data has been entered. In any case, the data will have to be edited, so the facilities provided by the simulation package for such editing are important.

More or less

Most of the packages in the accompanying sidebar are roughly equivalent in price and capabilities. CircuitPro is an exception. It is considerably more expensive than the other packages and is more powerful. At the same time its price, about $1,000, is well under that of the very sophisticated circuit simulation software packages used by professional integrated circuit designers.

Most of the packages can handle five basic circuit elements (resistors, capacitors, inductors, voltage and current sources); active devices often must be modeled with combinations of those basic elements. Other packages also handle active devices.

At the other extreme are the EE1 and EE2 packages. These do no circuit simulation at all. Instead they provide a selection of specialized calculations that can be useful in circuit design. The EE1 includes 17 different calculations for dc circuits, of which seven have to do with charge and discharge in RC or RL component combinations. The package does not go so far as to deal with RLC combinations. There is also a table that displays resistances and fusing currents for various gages of copper wire.

The EE2 package (for ac circuits) offers similar facilities. Here the calculations include such assorted items as complex number arithmetic and calculations for twin-t filters, skin effect, radiation from a wire pair, bandwidth-rise time and transformers. The wire table is also included in this package.

Circuit-design software

ACAP
Limit: 40 nodes
Circuit elements: basic five plus conductance, voltage-controlled current sources
Active devices: user-modeled
Functions: node voltages, mean and standard deviation of node voltages, output frequencies, radian frequencies, output in decibels
PC type: IBM/PCs, most other types
Price: under $50
Vendor: DYNACOMP, 1064 Gravel Road, Webster, NY 14580; 716-671-6160

ACIRC
Limit: 40 nodes
Circuit elements: basic five
Active devices: transistors, FETs and op-amps
Functions: phase angles, voltages and gains at node
PC type: IBM/PCs and compatibles with 192K main memory
Price: about $100 (includes DCIRC package)
Vendor: FB Circuit Products, 5234 Longfellow Way, Oxnard, CA 93003; 805-986-2276

ACNAP
Limit: 30 nodes
Circuit elements: R, L and C components, dependent current sources
Active devices: user-modeled
Functions: node magnitude and phase response, sensitivity analysis, Monte Carlo analysis, noise equivalent bandwidth, time-domain response (signal processing package required)
PC type: IBM/PCs and most other types; PC- or MS-DOS requires 256K main memory; CP/M-80 requires 62K; TRS-DOS requires 48K
Price: under $100
Vendor: BV Engineering, 2200 Business Way, #207, Riverside, CA 92501; 714-781-0252

CircuitPro
Circuit elements: 15 (basic five plus diodes, voltage-controlled current and voltage sources, current-controlled current and voltage sources, junction FETs, mutual inductors, inductors, MOSFETs, BJTs, transmission lines, independent voltage sources)
Functions: frequency response, time response, sensitivity analysis
PC type: IBM/PC/XT/ATs (PC version of the UC Berkeley Spice simulator)
Price: about $1,000
Vendor: E/Z CAD, 5589 Starcrest Drive, San Jose, CA 95123

DCIRC
Limit: 40 nodes
Circuit elements: resistors (50), voltage sources (10), current sources (10), diodes (10)
Active devices: stored models for transistors (25), FETs (10) and op-amps (10)
Functions: Voltage, current and power for components; node voltages; input and output resistance; sensitivity analysis
PC type: IBM/PCs and compatibles with 192K main memory
Price: about $100 (includes ACIRC package)
Vendor: FB Circuit Products, 5234 Longfellow Way, Oxnard, CA 93003; 805-986-2276

DCNAP
Limit: 30 nodes, 200 components
Circuit elements: basic five, plus dependent current sources
Active devices: user modeled
Functions: node voltages; current, voltage and power for circuit branches; sensitivity analysis; worst-case analysis
PC type: IBM/PCs and most others (memory limitations are the same as with ACNAP)
Price: under $100
Vendor: BV Engineering, 2200 Business Way, #207, Riverside, CA 92501; 714-781-0252

Tracking down remote control problems

By Conrad Persson

The infrared remote control is a commonly used accessory for consumer electronics products. These devices are convenient and reliable, but occasionally they do break down. Here are a few procedures to follow if you encounter remote-control products that malfunction. Because these suggestions were adapted from RCA servicing information, they are specific to RCA products, but the methods can be generalized to some degree to suggest approaches to other product lines.

How the remote system works

The FS Scan Remote system (see the block diagram in Figure 1)

Persson is editor of **ES&T**.

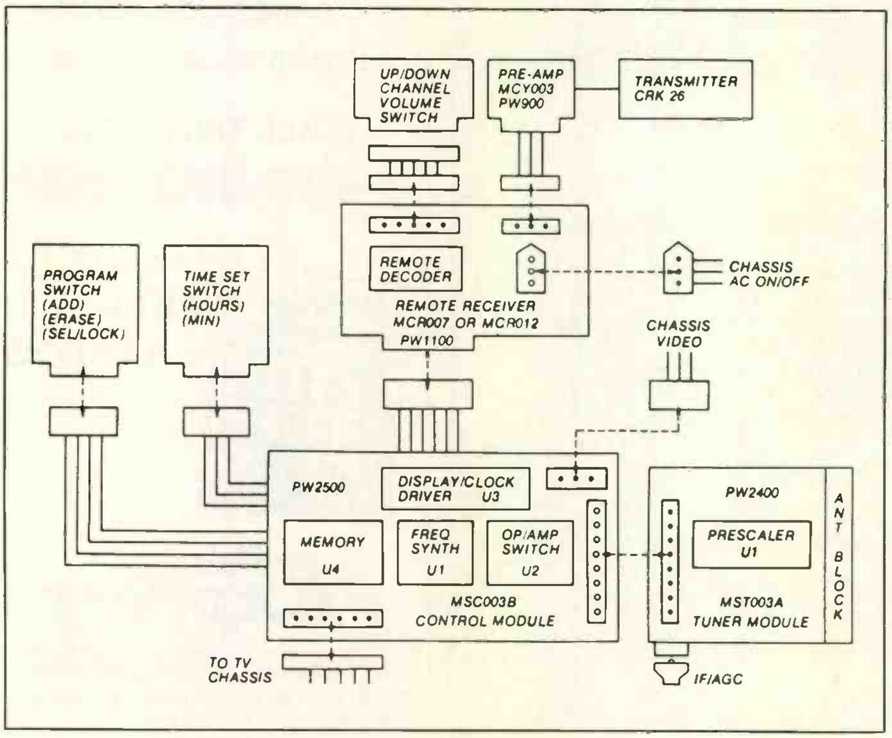
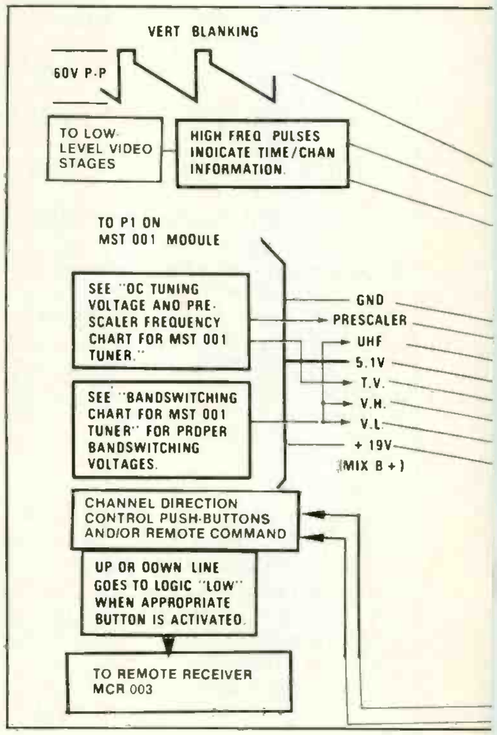


Figure 1. Block diagram of the remote tuning system.



uses a frequency synthesizer chip, an op-amp chip, a memory chip and an on-screen channel-display/clock chip. These ICs and associated components make up the MSC 003 tuner control module. (Figure 2 shows the PC board layout for the scan remote system.) This discussion will focus on the display/clock interface and remote servicing procedures. (For further information on how infrared remote controls operate, see "What Do You Know About Electronics?" in the April and May 1987 issues, titled "Infrared Remote Controls" and "More on the Basics of Infrared Remote Controls," respectively.)

The scan remote system includes the MCR 003 remote receiver, which uses a remote decoder IC. (Figure 3 shows the pin-out diagram.) This IC processes channel up/down, instrument on/off, and volume up/down information from the remote-control unit via a pre-amp and then sends appropriate voltages to the control module. The remote receiver also processes function commands from the manual push-button assembly located on the television.

Also located on the remote receiver is a +11Vdc regulator that provides dc voltages to the remote receiver and pre-amp board (as long as the television is connected to the ac line).

A separate transformer provides ac power to the regulator for standby and operation voltages to the remote receiver and pre-amp. A relay provides on/off power to the TV receiver.

Symptoms associated with remote control

Symptoms of problems with the time-setting mechanism include:

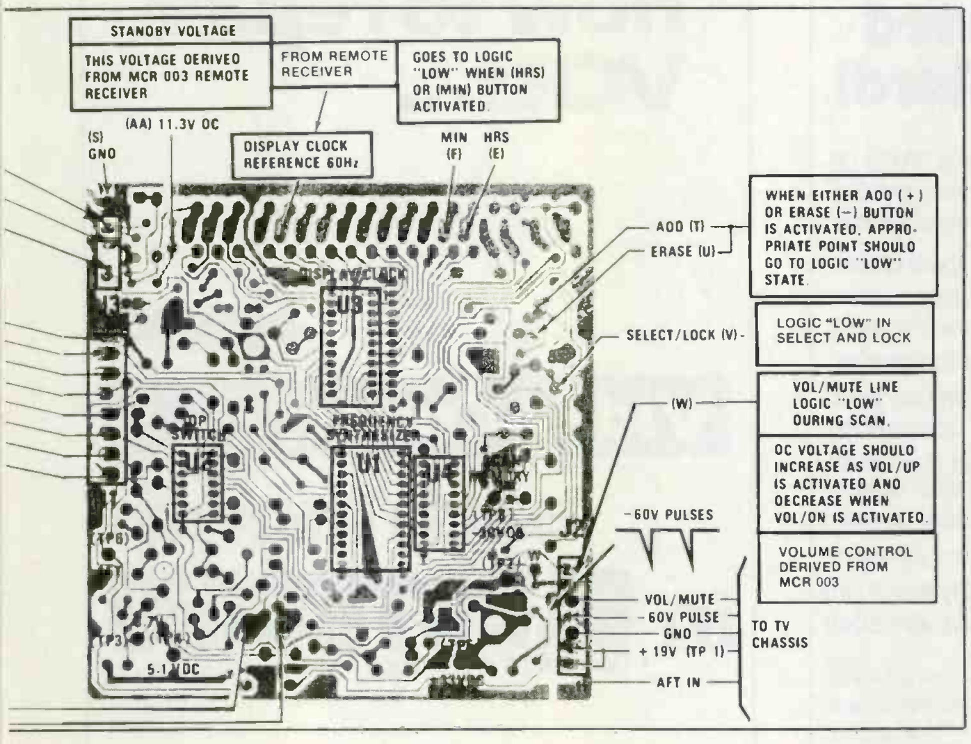
- Inability to set time.
- Erratic display.
- Loss of time display.

Symptoms of problems with the channel selector include:

- No channel up/down – remote.
- No channel up/down – manual buttons.
- No channel up/down – remote or manual.

Symptoms of problems with the volume control include:

- No volume up/down with remote and/or manual buttons.



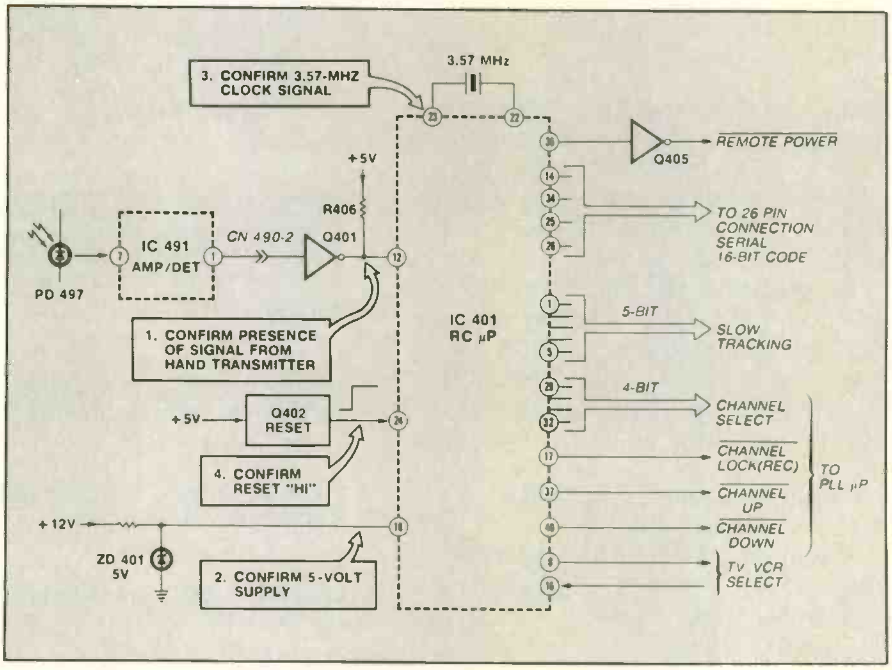


Figure 3. Pin-out diagram of the remote-control decoder IC.

- Improper volume up/down with remote and/or manual buttons.
- No on/off action from either remote or manual buttons.

Other possible symptoms:

- No remote-control action.

Servicing procedures

Use an isolation transformer, disconnect the line cord during all static checks, and use insulated clipleads for dynamic checks.

As a precaution, check all interface connections and wiring to and from the remote control module, the remote receiver, the pre-amp and all other assemblies associated with this system.

Display problems

Symptom: You are unable to set the time, the display is erratic or has been lost altogether.

Display problems can be defined as erratic or distorted screen digit display or no display with otherwise normal operation. Such problems are usually confined to the clock and display IC, located on the control module, or to connector problems. If you encounter display problems, replace the control module. A defective display assembly also may cause video problems. If you suspect that video problems are caused by the display system, remove the connector to see if the problem clears.

Failure of the system to maintain the correct time of day is a comparatively improbable situation without other symptoms being evident. If you encounter this:
1. Check for possible intermittent power interruptions. If power to the TV set is interrupted, the time-of-day display will be lost when power is restored, and the clock will have to be reset.
2. Check the time-set switches and cabling for possible intermittents.

Channel-changing problems

Symptom: No channel up/down–remote.

Confirm good connections between the remote receiver and the pre-amp. Monitor logic conditions at pins 9 and 11 of the remote decoder on the remote receiver module. This should go low when a channel button is depressed. If the logic condition does not change, the problem may be a defective component on the remote receiver board. Confirm the presence of +11Vdc to the remote decoder IC and to the pre-amp board.

Symptom: No channel up/down–manual buttons.

If the remote receiver responds to remote channel up/down, check connections between the remote receiver and the manual button assembly.

Symptom: No channel up/down–remote or manual.

Check logic conditions at X and Y on the control module (see Figure 2). If proper logic conditions are available on the control module but the correct command function doesn't occur, replace the control module.

Volume problems

Symptom: Improper volume up/down or no volume control–remote.

Confirm good connections of the remote receiver and pre-amp. If connections check out, replace the remote receiver.

Symptom: Improper volume up/down or loss of volume control–manual buttons.

Confirm good connections between the manual button assembly and the remote receiver. If the problem persists, replace the remote receiver.

Symptom: Improper volume up/down or loss of volume control in remote or manual operation.

This usually indicates a problem associated with the remote decoder IC or within the TV sound section. First monitor the dc voltage at point W on the remote control module (see Figure 2). Press the volume up/down buttons and confirm that dc voltage tracks when the appropriate button is pressed. If the voltage does not change, replace the control module.

Other remote control problems

Symptom: No remote-control action (manual OK).

A problem such as this usually indicates a defect in the remote transmitter, the pre-amp or the remote receiver.

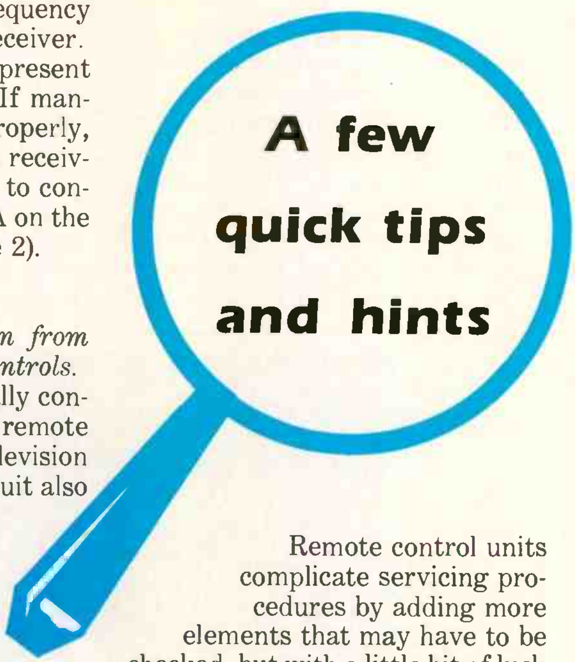
- Check the transmitter battery.

- Confirm correct function command frequencies of the transmitter by using a frequency counter at the remote receiver.
- Confirm that +11Vdc is present at the remote receiver. If manual tuning operates properly, the remote decoder IC is receiving +11V. A good place to confirm +11V is at point AA on the MSC module (see Figure 2).
- Try a substitute module.

Symptom: No on/off action from either remote or manual controls.

On/off problems are usually confined to defects on the remote module; ac power for the television is via a switching relay circuit also located on the module.

When you press the power button, listen for a click from the relay. A click will indicate whether the dc control voltage is getting to the control winding, and will suggest that the remote receiver is operating properly.



Remote control units complicate servicing procedures by adding more elements that may have to be checked, but with a little bit of luck you can determine whether a problem is related to that circuitry.

Whenever a remote control doesn't work or operates erratically, start by replacing the battery with the recommended replacement. If that doesn't solve the problem, you can make a preliminary check of the remote unit by aiming it at a special card that is sensitive to infrared light. If the target on the card lights with a flickering light when you press any of the control buttons, you have confirmed that it is operating.

The next step is to substitute a known-good remote unit for the inoperative one. Make sure there is nothing covering the infrared receiver on the set. If the substitute remote control operates the set, you have isolated the problem to the remote control.

Troubleshooting the remote-control function of a consumer electronic product is a lot like troubleshooting any other aspect of the unit: Understand the operation of the circuits, isolate the cause of the problem through checks and substitutions, and repair or replace the defective segments. ES&T

Books

Computer Electrical Power Requirements, by Mark Waller; Howard W. Sams, 200 pages, $19.95, paperback.

This in-depth discussion of power regulation problems and solutions for mini, mainframe and microcomputers addresses power regulation and how to use the proper electrical power. Topics covered include: utility power, grounding, lightning, static, noise and transients and their effects on personal computers and office electronics. The book also discusses isolation, distribution and voltage regulation, and covers the different types of power conditioning equipment.

Published by Howard W. Sams & Company, 4300 W. 62nd St., Indianapolis, IN 46268; 800-428-SAMS.

Illustrated Encyclopedic Dictionary of Electronics, 2nd Edition, by John Douglas-Young; Prentice-Hall, 692 pages, $16.95, paperback.

This ready-reference manual contains up-to-date technical data, terminology and "how it works" information in a combination dictionary/encyclopedia format. The book contains a list of alphabetically arranged electronic terms, detailed illustrations, charts, tables, schematics, formulas, graphic symbols and conversion factors. There is also an expanded encyclopedic treatment of the main branches of electronics, including transistor circuits, optical communications, computers, microelectronics and nuclear physics.

Published by Prentice-Hall, Englewood Cliffs, NJ 07632; 800-223-1360.

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2539-1...JC Penney – 685-2085-00, -10
2539-2...JVC – C-2046
2538-1...Panasonic – CTH-1942R, -1949R
2541-1...Panasonic – CTH-1922
2543-1...Panasonic – CTH-2780R, -2787R
2537-1...Quasar – WU9410AU/18AP/39AP (CH. LMC110)
2542-1...Quasar – TL9839AP, TU9810AU/15AD/18AP
2537-2...RCA – FMR425E/25W/40W/55W/66W (CH. CTC120C)
2538-2...RCA – CHASSIS CTC136A, CTC136D
2541-2...RCA – FMR2622T/23E (CH. CTC131AA)
2540-1...SEARS – 564.41401650
2542-2...SEARS – 564.42951650/51/52
2543-1...SEARS – 564.42101650, 564.42101651
2540-2...SONY – KV-1326R (CH. SCC-7450-A)

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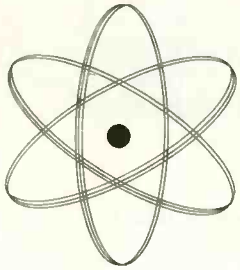
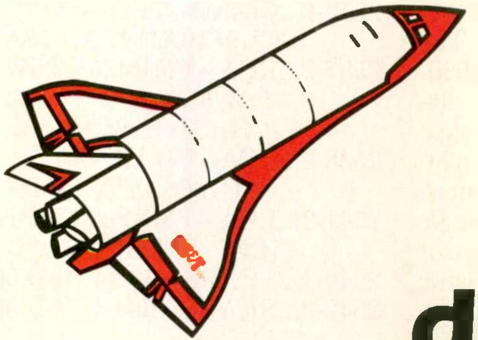
ES&T

What do you know about electronics?





A trip to the deathnium traps

By Sam Wilson, CET

In the last issue we borrowed the space ship from "Fantastic Voyage" and took a trip into a small block of germanium. Stopping just inside the surface, we observed Brownian motion and intrinsic current. We will now make a return trip to observe some new sights.

Our lab assistants are told to place a very small opaque dot behind us after our space ship enters the block of germanium. Special lab equipment is needed because we have been reduced to a size that is invisible to the human eye.

Just inside the surface we stop and wait. When the black dot is in place we signal the lab assistants to shine a very bright light on the surface. The light penetrates the surface and bathes the atom in an eerie glow.

Huge objects that look like boulders come crashing into the material from behind. They are photons–that is, particles of light.

We are protected from these photons because they cannot pass through the black dot that was placed behind us. The high-speed boulders crash into the atoms of germanium and knock electrons loose. This greatly increases the intrinsic current that we noted in our previous journey.

At our signal the bright light is turned off and we move into the crystalline structure. It is necessary to provide our own light for this part of the journey.

We are still fascinated by the beautiful and orderly structure of atoms. Our space ship pulls alongside a place where a larger atom has been wedged into the crystal. It obviously does not belong there because it does not fit into the lattice structure.

This out-of-place atom is thrashing about, but it is firmly stuck. We are told by the guide that it is called an *interstitial atom*. It is, in fact, an atom of copper that has somehow become trapped between the atoms of germanium.

A passenger asks why electrons are landing on and taking off from this atom. We are told that the copper atom is a form of *deathnium* trap. It captures electrons momentarily, disrupting the flow of charge carriers through the material. If there are too many deathnium traps, the material is worthless for use in diodes and transistors.

We are reminded that the things we see on the trip through germanium are identical to what we would have seen if we had entered silicon.

At out next stop we observe in the lattice structure an atom that is slightly larger than the other atoms. An electron is circling it like a tiny moon. This is a *donor* atom used to make the block of germanium N-type. If an external voltage is applied, the circling electron can easily be pulled away from its atom.

While the circling electron is loosely attached to its atom, there is no unbalanced charge. It belongs there and it is both electrically and gravitationally attracted to its atom.

So, the N-type material is not negatively charged. (Nor is the P-type material positively charged.) A better name could have been chosen for these materials so as to avoid the mistaken idea that they are negatively or positively charged.

Our ship makes a wide 180° turn so we can emerge from the same side as we entered. However, our path is soon blocked by what appears to be a wall. All of the atoms along the surface of this wall have fallen out of place so that the lat-

Wilson is the ES&T electronics theory consultant.

tice structure is no longer intact.

It is another kind of deathnium trap. This one is called a *grain boundary*. We are told that this deathnium trap will make the germanium useless for semiconductor work.

You can see one or more grain boundaries in an ice cube. They look like an internal crack. However, if you turn the ice cube and try to look at the grain boundary on edge it will disappear.

We contact the lab assistants for help. Their computer plots a path around the grain boundary and we leave the surface of the cube. As we are being returned to full size we are told that we would surely have been stuck if we had tried to pass through the grain boundary. I decide against any future trips. I'm no hero.

The programmable Shockley diode

In a recent issue I noted the similarity between the model used for a Shockley diode and the one used for a 4-layer (Shockley) diode. (See Figure 1.) I had heard from some source – which I can't remember – that an SCR can be used as a Shockley diode if the gate is left open.

Two students at New England Institute of Technology in West Palm Beach, FL, decided to try it and got some astonishing results.

When Randall Wolf and Glen Langley tried to make an SCR into

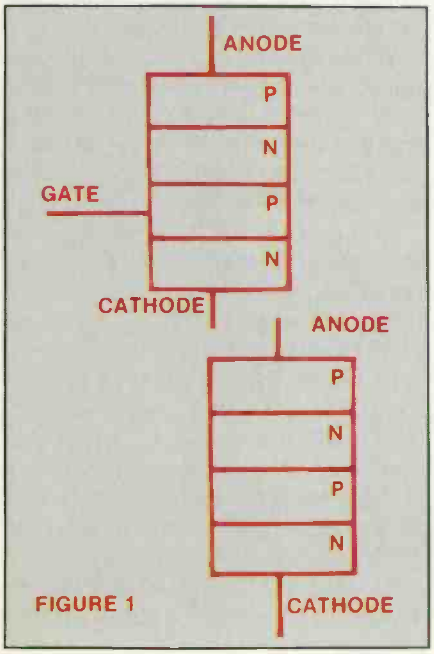


FIGURE 1

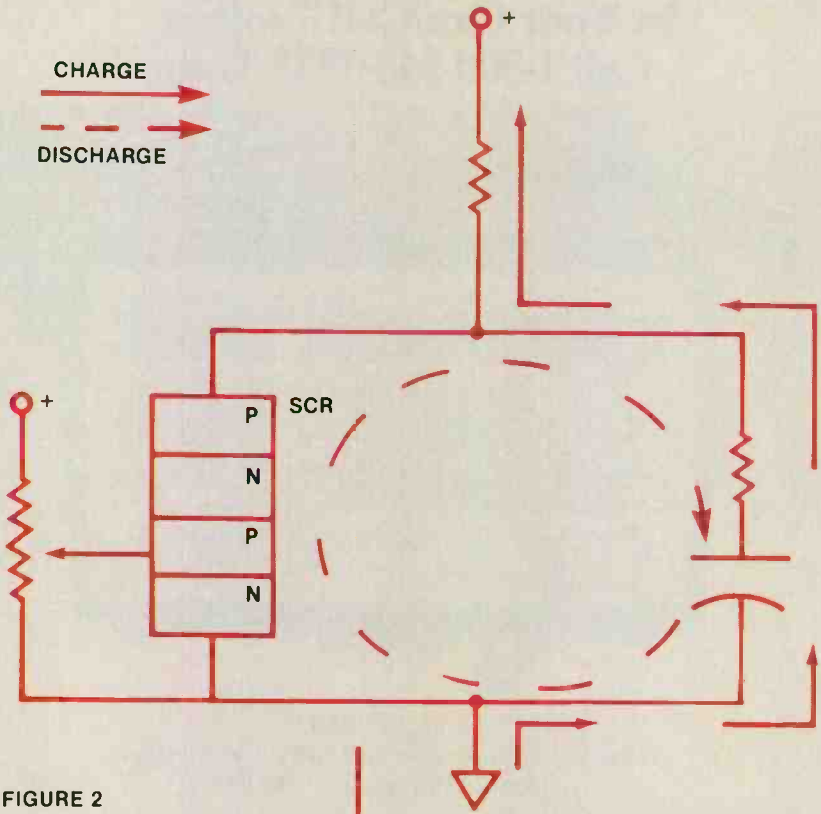


FIGURE 2

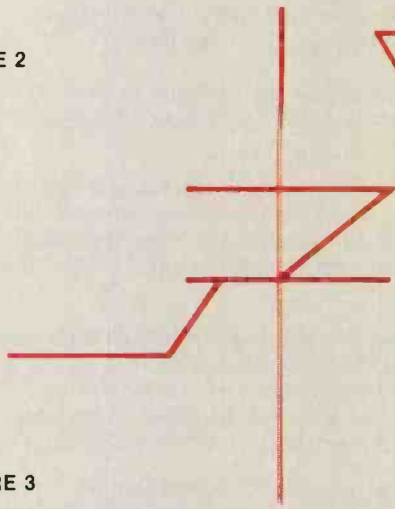


FIGURE 3

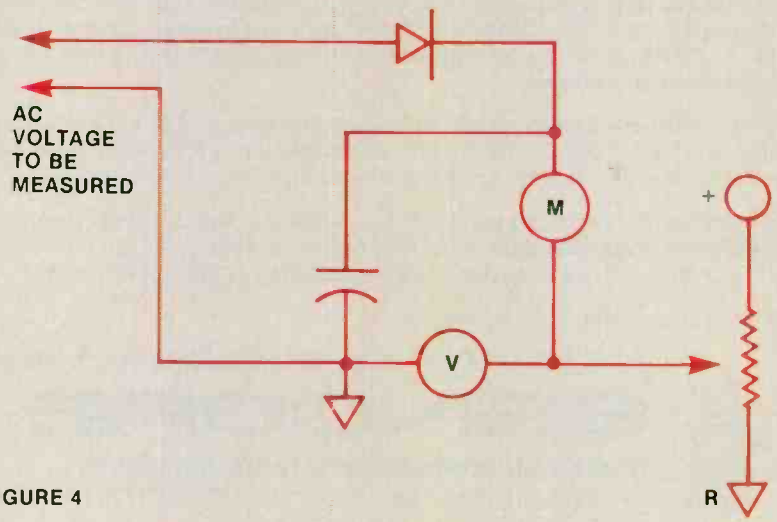


FIGURE 4

a 4-layer diode, they found they didn't have enough voltage to make the device break over in the forward direction. So they decided to lower the forward breakover voltage by applying a slightly positive potential to the SCR gate.

Figure 2 shows the circuit they used. Their reasoning was that if the device did break over, it should produce oscillations. The arrows on the schematic show the charge and discharge path for the resulting relaxation oscillator.

The device did break over and oscillation occurred. More important, the frequency could be changed. Therefore, changing the gate voltage changes the forward breakover voltage. That makes it a *programmable 4-layer diode*.

The students have applied for a patent disclosure letter. Figure 3 shows their suggested symbol.

I, for one, never cease to be amazed at the innovative ability of students!

The slide-back meter

I had a chance to talk with my friend Earl Tickler at the recent NESDA/ISCET/TESDA convention in Memphis, TN. His students at RETS (in Baltimore) requested that I discuss the slide-back voltmeter in my article. It was mentioned in a previous "Test Your Electronics Knowledge."

The slide-back meter is used primarily to measure the peak voltage of a sine wave. The basic circuit is shown in Figure 4.

When there is no ac voltage applied, the sensitive meter reads zero current. Actually, a very small amount of leakage current may flow, especially if the probes are not isolated from each other.

When the ac voltage (to be measured) is applied, it is ½-wave rectified by the diode. The arm of R is adjusted until the current meter reads just a hair above zero.

In other words, the cathode of the diode is made positive enough that it will not conduct. The reason you want a very slight indication on the current meter is to make sure you are just at the peak point of the ac voltage input.

At that point the voltmeter indicates the peak value of the unknown voltage.

The question asked by others listening to our conversation was: "Why bother? You can do the same job with any modern oscilloscope." There were several replies that are worth considering.

- You wouldn't know whether you liked the idea if you didn't know what it was.
- It is cheap. Some young experimenters haven't obtained an oscilloscope yet, so this gives them a way to measure the peak voltage.
- It is important to periodically review some of these older techniques. There may be an application in modern technology.

Stick-on meter

No, this isn't another meter circuit. Don Turner, CET, of West Palm Beach, FL, sent this tip.

When making measurements in the field, he got tired of trying to find a place to put his VOM, so he attached a suction cup to the back of the meter. He used epoxy, but he said that a small screw could also be used.

Whenever he makes measurements, he just sticks the meter onto a nearly flat, smooth surface.

If any other reader has a favorite technique, please send it along.

A letter from Raymond McCoy

Dear Sam:

At the end of your "What Do You Know About Electronics," page 46 of the May 1987 issue, you quoted a college professor as stating, "A battery cannot produce voltage at any time unless current is being drawn from that battery."

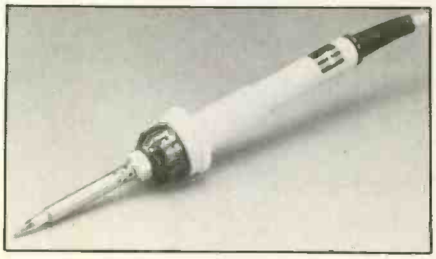
In my opinion, a battery is *always* drawing current. A better way to phrase the statement is: "A battery is always producing voltage because current is always being drawn due to its discharge current (no matter how minute). This discharge current is created because *NO* insulator is perfect."

Thanks for the letter, Raymond McCoy. I found your comments on the battery interesting. According to your idea of the imperfect insulator, it could very well be impossible to prove that current is not required for producing a battery voltage.

Products

Industrial soldering irons

O.K. Industries has introduced the SA-8 industrial-power soldering iron series. The ergonomically designed irons have a 3-wire grounded power cord and a maximum equivalent rating of 30W, 40W and 50W.



Features include: accurate temperature stability, which prevents damage to boards and components; quick heat-up time with rapid temperature recovery; silicone rubber heat guard for operator comfort and a safe, positive grip; a long-life, corrosion resistant tip; and a grounded tip for CMOS-safe soldering.

Circle (75) on Reply Card

Parallel-to-serial converter

The model 232 PSC parallel-to-serial converter from *B&B Electronics* gives users the convenience of another PC serial port. The male DB25P connector inputs parallel data using the standard PC pinout. The RS-232 serial data is output on pin 3 (RD) of the female DB25S connector. This port is configured DCE for direct connection to most serial printers. The pins 4 (RTS) and 20 (DTR) are RS-232 inputs used to stop the computer from outputting data when the printer is busy. The converter comes with an ac power supply and may also be programmed for 150 baud to 9,600 baud, parity, 7 or 8 bits, number of stop bits and busy input on pin 4 or pin 20.

Circle (76) on Reply Card

Tool kit

A 26-piece tool kit in a fold-up plastic case is available from *Xcelite*. The kit, model 99SMWX, contains a soldering iron and tip, a wire stripper, nine nutdrivers, Phillips and slotted screwdrivers, a wrench, a reamer, an extension bar for the nutdrivers and screwdrivers, and two screwdriver handles.

Circle (77) on Reply Card

Monitor cleaner

Chemtronics has introduced Screen Prep, a 2-part screen-cleaning system that consists of two disposable cloth pads sealed in twin foil packets. The first packet contains a wet pad, premoistened with a cleaning solution that removes dirt, fingerprint oils and dust and also controls screen static. The second packet contains a soft, lint-free pad for drying the screen.

Circle (78) on Reply Card

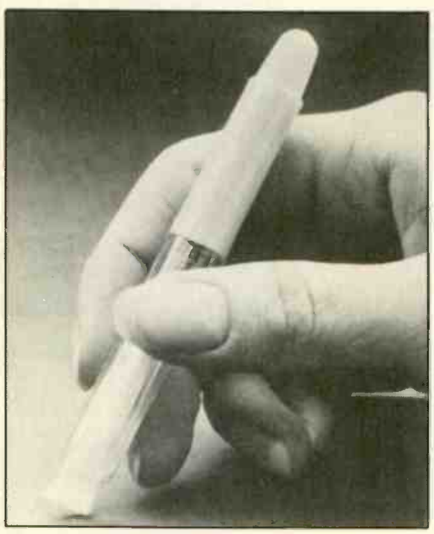
A/V soldering course

Hexacon Electric Company is offering a slide and audiocassette training program for entry-level personnel who will be performing wiring and hand soldering. The program describes the techniques required for correctly soldering turret, bifurcated, hook and cup terminals, and shows how a good solder joint should look.

Circle (79) on Reply Card

Cleaner/burnisher

The Superbrush cleaner and burnisher kit from the *Eraser Company* contains a holder with three interchangeable refills (coarse and fine fiberglass and stainless steel). Each refill gives a different cleaning action, ranging from a fine polish to a coarse sandpaper finish.



The kit may be used to clean electrical contacts, deburr small metal parts, remove rust from tools, clean motor commutators, polish molds or clean printed circuit boards.

Circle (80) on Reply Card

Power control unit

DATA SPEC has introduced the PC1025 multifunctional control unit, part of the Director Series. The unit incorporates surge suppression, an A/B data switch, a digital LED clock and individual switching capabilities for up to five components.

Five front-mounted on/off switches for the computer, printer, monitor and two auxiliaries provide power to specific components as needed, and a master switch powers up the entire system.

Circle (81) on Reply Card

Cleaner

The MCC-DFX Genesolv solvent from *Micro Care Chemical Corporation* cleans without the use of chemical additives that present safety hazards. The non-flammable fluorocarbon solvent removes organic and ionic contaminate residues associated with all commercial rosin-based fluxes and solder pastes.

The cleaner can be sprayed directly from the can or it can be applied with the Trigger Grip remote applicator, which dispenses the solvent through a natural bristle brush.

Circle (82) on Reply Card

Oscilloscope with cursors

Leader Instruments has introduced the model LBO-2060 60MHz CRT readout oscilloscope with cursors, which allows the user to observe waveforms, setting conditions and measured values on a single display. The scope reduces setup time by displaying the salient setting conditions such as CH-1 and CH-2 sensitivity, main and delayed sweep time and triggering controls.

Circle (83) on Reply Card

Soldering/desoldering station

The Twin E999 electronic, temperature-controlled soldering/desoldering station from *ELVO* has an operating range of 392°F to 878°F. A Nichrome element wire provides 45s heat-up and instant recovery. Electronic 0V thyristor

switching protects sensitive components. The tip is grounded to ensure a voltage leakage of less than 1mV and has a temperature stability better than +10°F. Other features are automatic soldering tip cleaning; a dual-diaphragm, oil-free vacuum pump that provides 23-inch to 28-inch Hg of vacuum for desoldering; and a transparent handpiece for monitoring solder collection.

Circle (84) on Reply Card

Tool kit

Jensen Tools has introduced the Deluxe Tech School Kit #23B002, a tool kit for the advanced electronics student and skilled hobbyist. The kit includes 28 tools, including screwdrivers, nutdrivers, a wire stripper/cutter, pliers, scissors, wrenches, a hemostat, a mirror, holding tweezers and soldering equipment.

Circle (85) on Reply Card

Analog multimeter

A. W. Sperry Instruments had introduced the SP-5 pocket-size analog multimeter. The 4-function unit has 12 ranges, recessed test-lead connections and diode-protected meter movement. Ranges are 10/50/250/500Vdc; 10/50/250/500Vac; 0.5/50/250mAdc; 0-1MΩ (5kΩ mid-scale); and −20dB to +56dB.

Circle (86) on Reply Card

Torque gauge

Tentel has introduced the TQ-600 dial torque gauge, designed specifically for video VHS and Beta recorders. The gauge is calibrated in both clockwise and counterclockwise torque to 600g/cm for maximum accuracy.

Circle (87) on Reply Card ES&T

RMMs: Erasable and programmable

This is the third part in a 4-part series on non-volatile memories. Part one covered the basic read-only memory (ROM). Part two discussed programmable read-only memory (PROM), which is custom programmed by the user but cannot be erased and reprogrammed, and EPROMs, which can be reprogrammed.

Although EPROMs can be reprogrammed as often as necessary, making them less expensive to program and more practical for users who do not need a large batch of a particular program, EPROMs do have some drawbacks. First, EPROMs must be removed from their sockets to be erased and reprogrammed. They also take a long time to erase, and the UV erase operation erases all memory contents simultaneously, necessitating complete reprogramming even when only one byte (memory word) needs to be changed.

A different class of non-volatile memory is the electrically erasable and programmable ROM, which was developed as an improvement to the EPROM. This type of memory is generally used in applications where it is frequently (mostly) read, but may occasionally (seldom) be written to; thus it can be called a *read mostly memory* (RMM). This category includes two nearly similar types: the *electrically alterable* read-only memory (EAROM), and the *electrically erasable* programmable read-only memory (EEPROM, also abbreviated E^2PROM).

How they work

EAROMs use metal-nitride-oxide-semiconductor (MNOS) technology; EEPROMs generally feature n-channel, floating-gate technology, as does the EPROM. Although their gate structures are somewhat different, they are both electrically programmable and electrically erasable. They behave much the same way – a sufficiently high voltage applied to any of the memory cells causes the RMM to store a charge in the selected field-effect capacitor. The charge is retained almost indefinitely (at least 10 to 20 years).

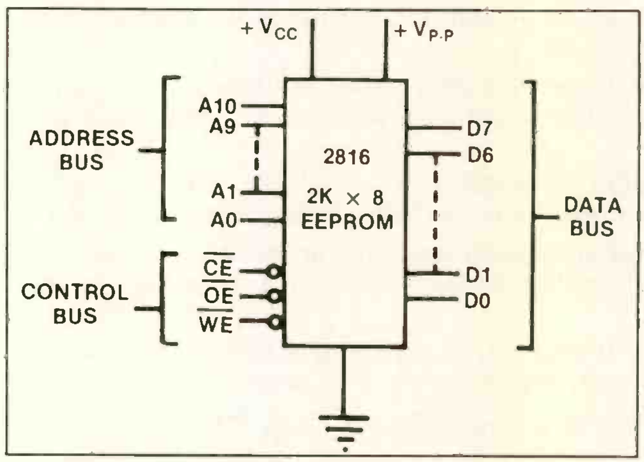


Figure 1. The EEPROM is electrically erasable, not UV erasable as the EPROM is, and features single-byte reprogramming. The extra WE (active-low write enable) control pin allows more combinations of control-bus logic, which gives the EEPROM more modes of operation.

Huneault is an electronics instructor at a community college in Ontario, Canada.

But the charge can also be removed (neutralized) electrically with a voltage of opposite polarity to the MOSFET cell. Thus the EAROM and the EEPROM are both electrically erasable and programmable. Byte writing (writing a single word into the RMM) takes about 5ms to 10ms. Although too slow to be used as RAMs, these RMMs have two distinct advantages over EPROMs: They feature a much faster erase speed (about 5ms to 10ms per byte), and they allow the user to erase individual words in the memory array without affecting the rest of the memory. Whole-chip erasure is also possible, and it too requires about 10ms.

Applications

Although EAROMs and EEPROMs have a limited life span of 10,000 or 20,000 erase and programming cycles, they are ideally suited to applications where they store important data for extended periods of time, such as tax tables in electronic cash registers, tab positions in CRT terminals, and tuning voltage codes in direct-access electronic tuners for radios and TV sets.

In the latter application, the RMM stores a different binary code for each of the VHF and UHF channel frequencies and also remembers the last channel viewed when power is turned off and back on again. When a channel is selected via the keyboard on the receiver's front-panel or hand-held remote-control unit, the corresponding memory code is read from the RMM and is either converted into an analog voltage (by means of a digital-to-analog converter) and applied to the tuner's varactors for channel selection, or it is processed by a microprocessor in a synthesized tuning system featuring a phase-locked loop (PLL).

No backup battery is needed to keep the data stored in the RMM; once programmed, the EAROM (or EEPROM) retains the codes in its memory cells for more than a decade, even when the TV receiver is turned off. If the set's owner moves to a different city where VHF/UHF channel assignments are different or where local cable TV features offset carrier assignments, the RMM can easily be reprogrammed for the new frequencies via the receiver's keyboard.

Note that unlike the EPROM, which must be removed from its socket for erasing and reprogramming, the RMM can stay right where it is, in circuit; the support circuitry necessary for erasing and programming operations is usually incorporated in the PCB on which the EAROM or EEPROM is mounted, or aboard the memory chip itself in some of the newer RMMs.

Another application of EEPROMs is in state-of-the-art digital displays on the instrument panels of modern automobiles. In an electronic odometer, for example, the data is stored in semiconductor memory. Because the mileage information must be updated continuously, a RAM is used to store the data. When the ignition is turned off or the battery is removed from the car, however, the data must not be lost. In this type of system, a sensor detects the loss of power and causes the mileage data to be transferred quickly from the RAM into an EEPROM. The data remains stored in the non-volatile EEPROM until power is restored, at which time the mileage information is returned to the RAM for a resumption of continuous updating. ES&T

ANSWERS to the QUIZ

Continued from page 6

1. Doppler effect. The change in pitch of a train whistle as it approaches and then leaves is the most familiar example of this effect. The pitch is higher as the train approaches and lower as it leaves because the sound shares the velocity of the train.

2. 0V. The voltages at the opposite ends of the transformer should be 180° out of phase, so they should cancel. This test is used to determine if there are shorted turns on either half of the secondary. With shorted turns there will be an ac output.

one-half the supply voltage, so I = 10V/500Ω = 20mA.

8. B. The voltage across R is equal to the rate of change of voltage across C.

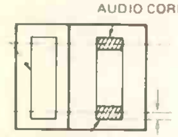
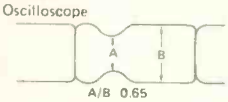
9. A. The input impedance of a MOSFET amplifier is *high*.

10. e. Actually, it would be better to use the Greek letter *epsilon*. This is a number that is often associated with rate of growth. If your calculator has lnx rather than e, the inverse lnx of 1.0 gives the value of e.

Video Corner

Adjusting the tape transport

If the picture produced by a VCR isn't all it should be, the problem could be in the tape transport mechanism. It's important that the path between the supply reel and the take-up reel is clean and stable. The tape transport is precisely adjusted at the factory, but when parts related to this section are replaced, it should be checked carefully and any necessary adjustments should be made. The procedures below, taken from the service manual for the GE model 1VCR2018W, give an idea of the kinds of checks and adjustments required to ensure that the tape transport in a VCR is operating properly.

Check item		Judgment	Tool/measuring instrument
Back-tension		30∼45 gcm (VTR in horizontal)	Back-tension meter
Guide pole		Tape should slide along the lower flange and not crease or curl.	By eye
Inclined guide and guide roller		Conspicuous creases or curls not present in tape. No adherence of dust.	By eye
Tape		Conspicuous distortion of the tape or change should not be present.	By eye
Impedance roller		Roller should rotate smoothly	By eye
AC head		Tape should keep contact fully with the control head core and audio head core. 	By eye Diagram on the left shows reference values.
Envelope		Conspicuous fluctuations should not be present	Alignment Oscilloscope
Playback staircase wave from alignment tape	Flatness Fluctuation	The ratio of the max. section and minimum section of the envelope should be 60% or more (with ½ output tracking position).	

Adjust the positions shown below depending on the parts replaced when parts are refitted or replaced.

1. When the upper cylinder is replaced

Guide roller height	Judgment
X value	Creases and curls should not occur in the tape
Switching point	Check fluctuation and flatness of the envelope
Video record level	Check.
VD (Dummy vertical sync)	

2. When the AC head is replaced

	Judgment
AC head height	Check the audio or control track width
AC head azimuth	Maximize audio playback level
AC head tilt	No slack at the top and bottom of the tape
X value position	Conspicuous audio level fluctuation should not be present

Literature

Industrial catalog

By writing on your company letterhead, or with any order, you may receive a free 480-page industrial catalog from *Joseph Electronics*. The catalog lists, describes and illustrates test equipment, tools and chemicals, wire/cable/connectors, batteries and chargers, electronic components, computer accessories and video and sound equipment from more than 100 national brands.

Another section features "value added services" stressing custom battery assembly.

Contact Joseph Electronics, 8830 N. Milwaukee Ave., Niles, IL 60648; 312-297-4200 (outside Illinois, call 800-323-5925).

Test instrument catalog

Sencore Electronics has released its 1987 fall/winter full-line catalog. The catalog includes instruments for testing video, audio, components analyzers and cable systems, plus waveform analyzers, IEEE instruments, and the complete line of instrument accessories.

Circle (125) on Reply Card

Technical supplies catalog

Contact East's latest catalog contains a selection of test instruments, soldering supplies, Contact East's exclusive line of tool kits, the latest in static protection, wire cable tools, power supplies, electronic adhesives, data and telecommunication equipment, and an extensive section devoted to precision hand tools.

Circle (126) on Reply Card

Precision tool folder

Minitool is offering a folder showing the company's line of precision miniature hand tools for laboratory and production tasks, as well as for fine assembly work, delicate deburring jobs and printed circuit artwork and repair. Shown are sets with hardened tool steel and carbide tips, technician sets, Tinitool kits, diamond scribers, electrical micro-test probes with interchangeable probe handles, micro-test probes with integrated handles and audible beepers, precision pin vises, sapphire burnisher and direct-reading micro-rulers. Also shown are micro-lapping kits, zirconium ceramic scissors and ceramic tipped tweezers.

Circle (127) on Reply Card

DMM brochure

John Fluke Manufacturing Company is offering a new brochure, "A Test Lab in Your Toolbox – The Fluke 8060A." The 16-page, color brochure describes how to use the 8060A digital multimeter in several different industries. Many working environments are used to explain procedures for current measurements, calibrating process and control systems, and testing the frequency measurement of motors and generators. Also included are tips for measuring the response of an equalizer, matching resistors in step attenuators, measuring non-sinusoidal waveforms and harmonics, plus other testing methods.

Circle (128) on Reply Card

Audio servos

In past columns, I've talked about CD players and the complex servos used to keep the micron-sized laser beams focused on the correct track. These circuits strain the limits of conventional home entertainment technology, as anyone who's ever been stuck with a balky CD player knows. But what about the garden-variety servos in phonos and tape decks? We see these much more often.

To review, a servo is a device that uses its output to modify its input, so as to keep some operational parameter, such as motor speed, constant. Take a look at Figure 1, a simple servo circuit with five essential components:

1. a motor.
2. a feedback circuit that has a signal, current or voltage dependent on motor speed.
3. a reference signal, current or voltage that sets the desired operating point.
4. a comparator that accepts inputs 2 and 3 and produces a correction voltage in an attempt to equalize them.
5. a drive amplifier controlled by the comparator.

Why bother with a servo at all? Why not simply use a synchronous motor and let the power company do the regulation? Actually, that was common a few years back. Remember Dual turntables with idler drive and large hysteresis-synchronous motors? They ran almost perfectly in sync with the ac-line frequency.

As good as it was for the times, line synchronization had several drawbacks. First, the power-line frequency, while having a long-term accuracy within an order of magnitude of WWV, might vary a percent or two in the short term. Of course, if you used a line-operated strobe to check speed, you'd never notice it, because both the strobe and the motor used the same reference.

Second, when this type of equipment was used in different countries, it required conversion of operating voltage and necessitated separate motor pulleys for 60Hz and 50Hz systems. How many of you remember waiting weeks or months just to get a 60Hz pulley for a customer returning from a tour of duty overseas?

Not all countries control their line frequency as fastidiously as the United States, so speed accuracy could not be guaranteed. Plus, a hysteresis synchronous motor always evidences some slip or lag relative to the input waveform, and this slip becomes more severely detrimental to speed accuracy with the varying loads typical in normal use of a turntable or tape deck.

Using dc motors

To get around these problems, producers of high-fidelity equipment decided to go with dc motors, which operated independently of the power-line frequency. As most of us have noticed, the speed of small dc motors is notoriously load-dependent. This wouldn't do, so early units used a simple voltage-regulator circuit. This wasn't a servo, because no feedback was used. The regulator transistor was thermally matched to the motor and was generally attached to the motor housing. Speed accuracy was within 3%, with a wow and flutter specification around 0.07% to

Vistain is ES&T's audio consultant.

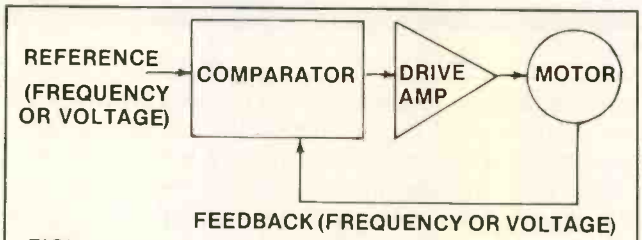
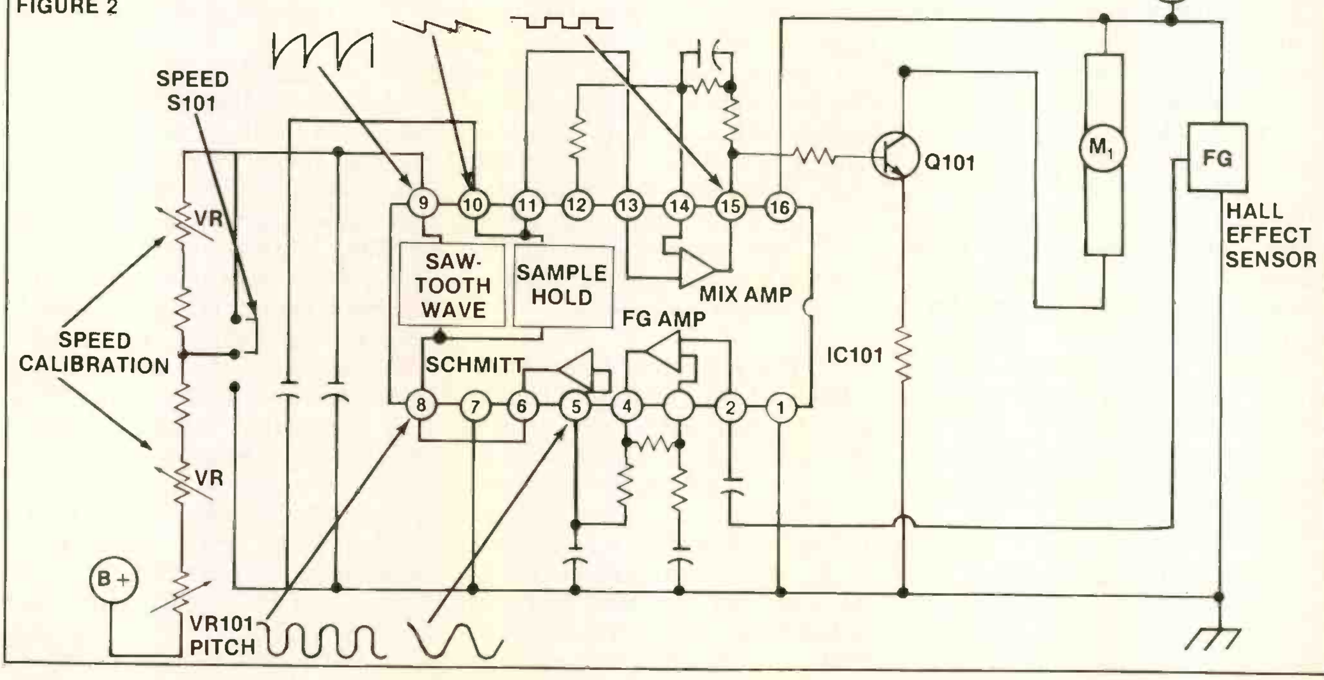


FIGURE 1

FIGURE 2


By Kirk Vistain

0.1% WRMS (weighted RMS). You can still find this arrangement in low- and mid-fi machines.

True servo systems

During the late 1970s, growing user sophistication and the inevitable specification wars forced manufacturers toward true servo systems. Increased availability of ICs made fabrication more practical and less expensive.

Two types of servo emerged. At the lower end of the market were FG (frequency generator) designs, and at the top, crystal-controlled designs. Figure 2 shows a typical FG phono servo that yields a typical flutter figure of 0.045% WRMS, quite respectable for an analog system.

Mounted inside the motor is a Hall-effect sensor, which varies its output voltage depending on the strength of the magnetic flux field around it. Rotation of a magnet ganged to the motor shaft causes a varying voltage output from the Hall-effect device, the net result being a sine wave frequency that directly tracks motor speed. This is the feedback component necessary in a servo.

Within IC101, the signal is amplified, level-shifted and squared by the Schmitt trigger between pins 5 and 6. Then it's compared to a sawtooth wave with characteristics set by the variable resistors VR101 or VR102, depending on the position of the speed selector S101. VR103 provides fine pitch control for either speed. Within IC101, the position of the squared FG signal samples the reference ramp voltage, the output becoming the servo correction voltage, which is amplified by Q101.

The normal operating point of the circuit is set so that, at the correct speed, the FG signal samples the ramp roughly in its center. If the speed decreases, the FG frequency decreases and samples the ramp at a lower voltage. The servo then applies a correction signal in an attempt to sample the ramp at the designed operating point. In other words, it speeds up the motor. The reverse occurs if the motor runs too fast.

Stability of this circuit depends on the quality of the components forming the sawtooth generator's RC network. The built-in strobe used by the operator for speed adjustment is no more than a neon lamp across the mains, so speed accuracy will depend on the line frequency unless it is set with a test record and frequency counter.

Troubleshooting

Let's say our example phono exhibits severe speed irregularity. We make a mechanical check. The table rotates freely, the belt seems good, the motor shaft turns smoothly with no rough spots or odd noises. PS voltage is on the money. Do we have a bad motor, servo IC, or what?

Looking at the FG signal is fruitless. It's there all right, and relatively clean, but the frequency varies erratically. The sawtooth at IC101, pin 9 is a perfect replica of what's on the schematic. (Given the quality of service information, the skeptic might find that highly unusual.) Next, see if the motor will run smoothly when freed from the servo.

You'll notice that the waveform feeding the base of motor drive Q101 is dc with a small component of ac at the sawtooth frequency riding on top. All the same, a dc voltage of about 1.5V substituted at this point ought to make the motor turn at roughly the correct speed. Aha! The platter rotates erratically, probably because of a bad commutator or brush inside the motor. ES&T

Readers' Exchange

Editor's note: Readers' Exchange items are published in the order they are received. We are happy to offer this service at no charge to you, our readers, but ask that:

- Items are legibly written or typed.
- Your name and address are included on the same page as your item (envelopes and contents often become separated). Phone numbers also may be included. Using your peel-off label is a good idea.
- You limit any item to no more than three units.

Please understand that **ES&T** is in production six weeks to two months *ahead* of publication date.

No ad requests will be accepted for Readers' Exchange without a *full, verifiable name, address AND phone number*. This information is necessary for ***ES&T*** files. Phone numbers will not be published, if so requested.

Wanted:

Sencore CG25 color-bar generator; variac; isolation transformer. *George Demaris, 7387 Pershing Ave., Orlando, FL 32822-5743; 305-277-3746.*

Plastic battery holder, new or used, for Panasonic AM/FM radio model 728; dual VC & SW, new or used, for Panasonic AM/FM stereo model RE 7671 (Sams 960), new part no. EVG765U40A53, old part no. EV-FK12L50A53. *William J. Maida, 274 W. Sabal Palm Place, Longwood, FL 32779; 305-869-6138.*

Two MRF 455A transistors; five 7868 tubes; 10 #12, 6V lamps for Bogen PA amps; one each bandswitch for Panasonic RF 2800 receiver #RSR 98W or equivalent; one printer and disk drive for the Tandy Color Computer II model 26-3127; and one each Z-80/CPM for the Apple IIe pro system. State price and condition. *Mike Adams, Haney Vo-Tech Center, 3016 Hwy. 77, Panama City, FL 32405; 904-769-2191.*

Service literature and repair manual for Rutherford stereo, model 73, chassis no. X912OU. Will pay for copies. *Mike Uhlich, 3329 Marsrow, Toledo, OH 43615; 419-841-8914.*

Source of "Standard HV transistor 508" or ECG equivalent; source of TA7147 video IC. *James C. Langford, 2202 Frankfort, Richland, WA 99352; 509-946-1455.*

Service manuals and source of replacement parts for older tube-type home and auto radios manufactured by Blaupunkt, Telefunken, Pye, Smith, Becker, Condor, etc. *Wilford Wilkes, Box 103, Brisbin, PA 16620; 814-378-8526.*

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New or used take up and supply platter with spindles for Akai reel-to-reel tape player, model 280DSS. *Bob Moole, Watters Appliance Center, 528 North Court, Carroll, IA 51401; 712-792-2525.*

SAMS Photofacts nos. 1,500 to 2,000; schematic for Advent projection television, model VB-761, or source for service data. *Wilfred Forgue, Willy's Electronics, P.O. Box 56595, North Pole, AK 99705; 907-488-1307.*

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Sencore LC53 Z-meter, $500; SCR 224, $20; SCR 250, $100; VA48 analyst, $750; SC60 scope, $800; FC71 frequency meter, $500; CB49 analyst, $650. *Ronald MacKenzie, 41 Wheelwright Lane, Levittown, Long Island, NY 11756; 516-579-8546.*

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