THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

# ELECTRONIC™

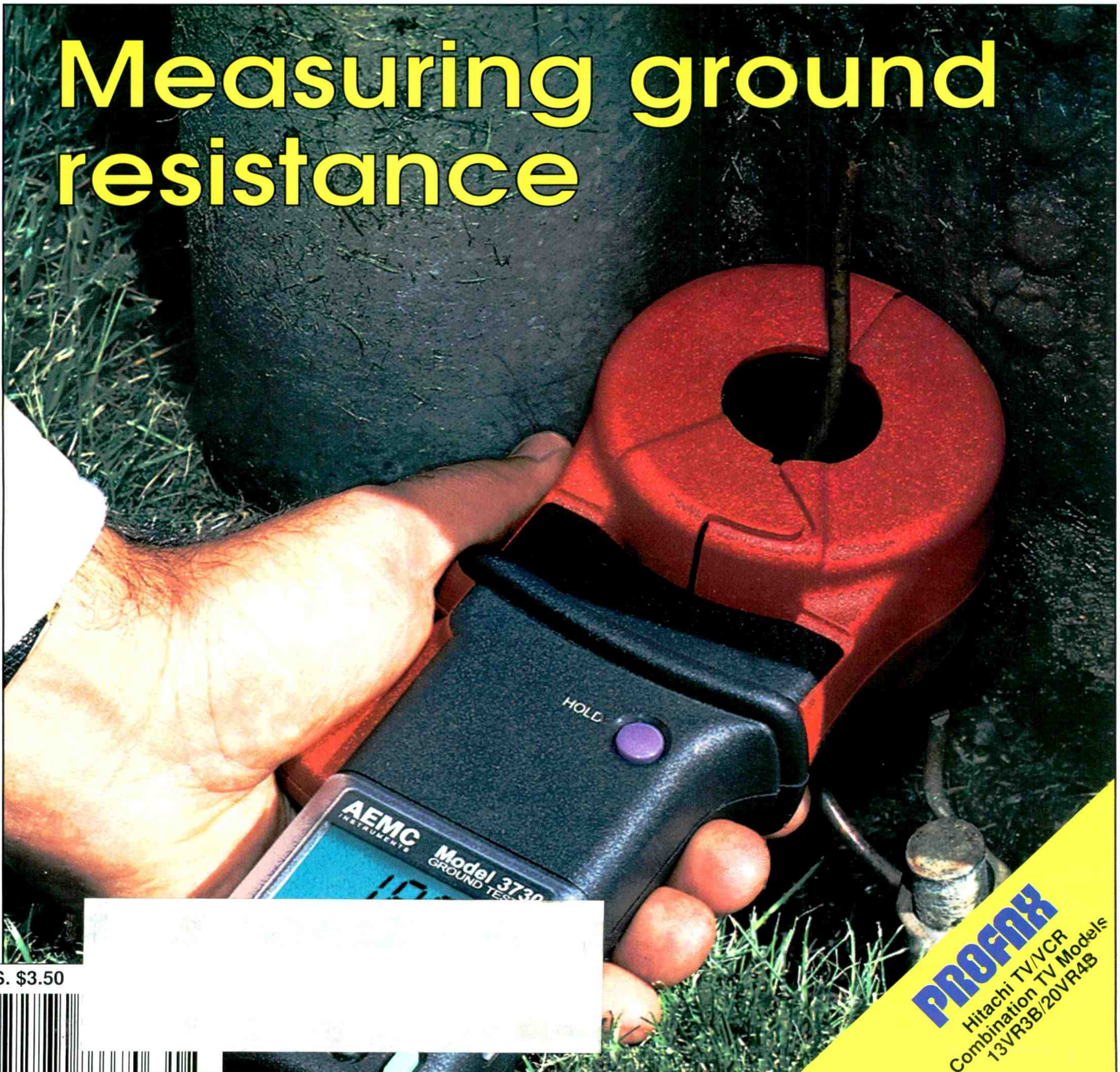
# Servicing & Technology

August 2000

## High-definition television

## The Dolby systems

## Measuring ground resistance

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Volume 20, No. 8 August 2000

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## Advertising Supplement



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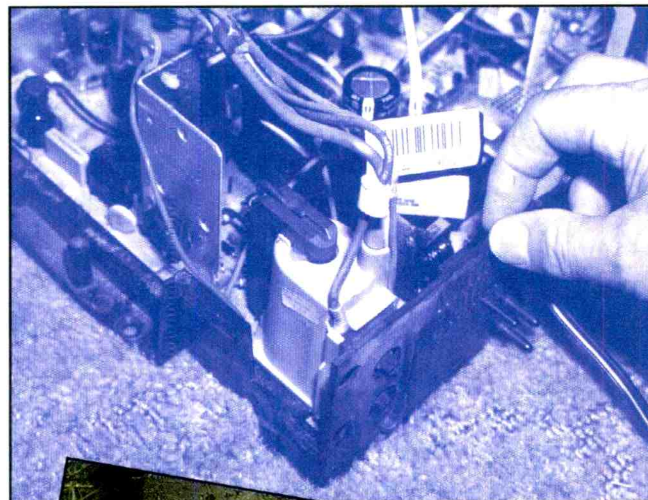

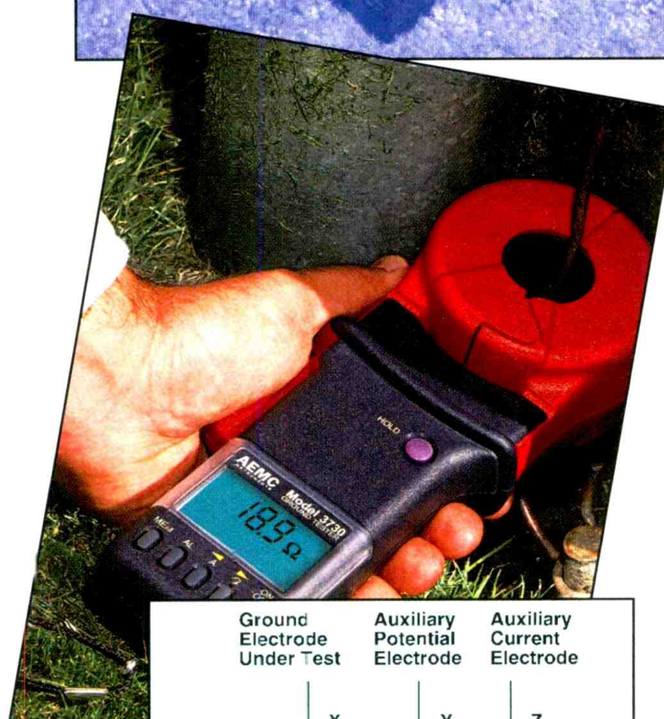


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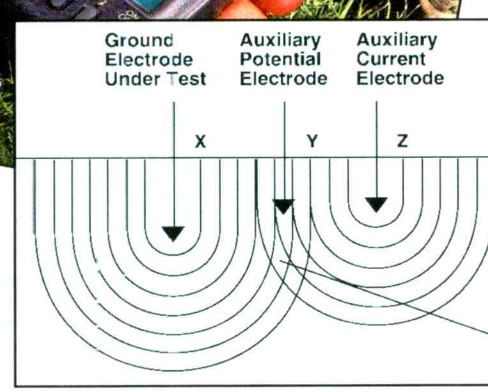


## DEPARTMENTS



### ON THE COVER

*There's only one way to determine if a grounding system is providing effective grounding for electrical or electronics systems: measure the resistance from the grounding electrode(s) to the surrounding soil. (Photo courtesy AEMC)*

# Editorial

*by Nils Conrad Persson*

Sometimes it's quite instructive to watch programs on TV. Sometimes you can learn things about life that you weren't aware of before. For example, I was watching a show on PBS last night; actually, it was the last episode of a three-part show called "The 1900 House." Watching that series can make you realize just how much has changed in the lives of humans over the past century.Although many people have nostalgia for the past, watching this show can't help make a viewer in the year 2000 glad he's alive now, and not then.

The idea of the program was to take an old home, one that had, of course, been "modernized," and restore it as exactly as possible to the way it would have been in 1900. Then the people who created the program interviewed dozens of families to find one that could adapt to such a situation, and have them live in the house for 90 days, forgoing all the conveniences that had been invented since then, just to see what it must have been like.

The electrical service was stripped out and replaced with gas lighting. There was no refrigerator, no electric (or gas either) stove, no telephone, no washer/dryer, no TV, VCR, or stereo.

As the family's time in 1900 progressed, they understood how much we take for granted all of the modern conveniences that we have today; the home entertainment, movies. Just the ability to pick up the telephone and call someone. Interestingly, while they missed the electricity and the electronics devices that we take for granted, there were some other fundamental products that we probably don't appreciate enough and wouldn't ordinarily even realize are relatively new to our world.

One of the products that they would have loved to have is the detergents that we have to wash our hair and our clothes. For clothes, they washed them in washing soda, but actually boiled them. And their hair was dull and lifeless (I know it sounds like a commercial) from washing with soap they had available.

After watching that, I'm just happy that I can sit here in my clothes, clean from those detergents, with sparkling hair (what's left of it), in my air conditioned office, illuminated with electric light, while I key this article in on my computer keyboard.

But another PBS offering last night pointed out that while we have so many electronic marvels available to us today, not everyone takes advantage of them. The program was "An unsuitable job for a lady," starring Helen Baxendale as Cordelia Gray, a young woman who started a small private detective agency. Ms Gray is a well-intentioned young lady who is becoming somewhat successful at detecting, even while she is making the mistakes that might be expected of someone new to the business.

The obvious lack of technology was the fact that in this day and age her agency did not have a personal computer. It occurred to me as I watched that any detective agency that didn't have a computer was hopelessly out of date. In one scene, Cordelia had obtained the first name and telephone number of a character, "Big Mickey," who might be harboring another character whom she wished to locate. In order to find the address of Big Mickey, she sent her assistant to the public library to search laboriously through the telephone directory to find that number so she could find his real full name and address.

As the story unfolded, presumably the search took hours, perhaps the entire morning. You try finding a telephone number in a phone book that's listed in alphabetical order by last name. If Cordelia had had a personal computer with internet access, all she would have had to do was to log on to the internet, connect to a website that could provide reverse telephone number lookup, enter the number, click the mouse pointer on "Search," and with a little luck, in less than a minute, all the pertinent name and address information for Big Mickey would have popped onto the screen.

The best thing is that that search is entirely free. But it gets even better. Well, for a detective agency, not necessarily for those of us concerned about personal privacy. For under a hundred bucks, Cordelia could have contacted an agency, still on line, that could have provided her, in a very short time, with a great deal of information about Mickey: past addresses, credit cards, and much more.

It's also interesting to speculate on which electronics marvels that have either been around for a short while, or have only recently been introduced, will be added to the group of products that have become essential, and will be owned by everyone, or will be owned by only a portion of the population. For example, radio, TV and telephone can be considered to be universal products. Well, sure, some people in the developed world don't have all of those, and a scant few may not have any of them, but the overwhelming majority of us do have all of them.

Today, a large proportion of the population of the developed world own cellular telephones, pagers, personal computers, but there's still a significant group of holdouts. And now we're seeing a whole new class of product come along: automobile navigation and communications systems. They've been around in small numbers, but now the numbers are growing.

I saw an ad in a magazine just recently for a luxury car that features a navigation system as standard. It's based on a global positioning system (GPS) that uses satellites to keep track of the position of the car on the surface of the earth, and superimposes a detailed map on the car's position on a viewing screen. As long as the system is operating, you know exactly where you are, and can plot a course for where you want to go.

And I'm not sure whether it's part of a similar system, or a stand alone device, but surely you've seen the commercials for the luxury car that has a system such that if you have an accident and the air bag is deployed, that information is relayed to some kind of a monitoring system, and the company contacts you, in your car, to see what the nature of the problem is, and if you need assistance.

We've come a long way from the relatively primitive situation people of the 1900s faced, but I have a feeling that the electronic journey has really just begun. What do you think? ■

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# ELECTRONIC
Servicing & Technology

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# News

## CEA and NCTA Reach Accord on Labeling Digital Television Sets

The Consumer Electronics Association (CEA) and the National Cable Television Association (NCTA) have announced that they have reached agreement on labeling information that will aid consumers in their purchase of new digital television equipment.

The CEA-NCTA agreement establishes the labeling to be used to inform consumers about the capabilities of various digital television sets to receive digital and interactive digital TV services. All digital sets will be capable of receiving both analog and digital programming from a digital cable system. Digital TV sets with full interactive capabilities will be labeled "Digital TV-Cable Interactive." Digital sets that lack these capabilities will be labeled, "Digital TV-Cable Connect."

"We're pleased to take this further step in the transition to digital television," said NCTA President and CEO Robert Sachs. "Consumers will benefit from this agreement because they will know exactly what to look for when they purchase a new digital TV receiver. No longer will ambiguous terms like 'cable ready' cause consumers confusion."

"With this agreement, we have now passed one more milestone on the road to DTV," said CEA President and CEO Gary Shapiro. "As our industry brings new DTV products into the marketplace based on this agreement, consumers will have full access to the spectacular picture, sound and interactive features of digital television via their digital cable system." Both Shapiro and Sachs praised FCC Chairman William Kennard for encouraging industry resolution of these issues.

On Feb. 23, the two trade associations announced technical specifications that will permit the direct connection of digital television receivers to cable television systems. At that time, the industries also announced agreement concerning how program and system information will be transmitted over digital cable networks to digital TV receivers. A yet-to-be-resolved copy protection issue involving parties in addition to CEA and NCTA is the subject of a current FCC rulemaking proceeding.

The agreement acknowledges that every digital TV set will not need to include a 1394/5C connector allowing reception of the full range of cable interactive services. However, all sets will be packaged with consumer information describing the features and functions of television sets with and without the 1394/5C connector. The descriptive information will appear in consumer electronics product manuals and brochures.

Sets labeled "Digital TV-Cable Connect" — those without the 1394/5C connector — will be capable of receiving analog basic, digital basic and digital premium cable programming from any cable system that offers digital service. "Digital TV-Cable Interactive" sets — those with the 1394/5C connector — will be able to receive those services and other programming, including impulse pay-per-view, video-on-demand, enhanced program guides and data enhanced television services with a digital set top box. CEA and NCTA have agreed to continue discussions and expect to reach an agreement on the labeling of digital set-top boxes that will work with the "Digital TV-Cable Interactive" DTV sets. With approximately 68 percent of U.S. households receiving television programming via cable, these agreements mark an important point in the U.S. transition to digital television. CEA estimates that the first digital TV receivers bearing the new labels will reach market by the fourth quarter of 2001.

NCTA is the principal trade association of the cable television industry in the United States. Its members include owners and operators of cable television systems serving over 90 percent of the nation's cable television households and over 100 program networks. Its membership also includes cable equipment suppliers, and others interested in or affiliated with the cable television industry.

## April Video Sales Up in 2000

*TV/VCR Show Greatest Monthly Gain, DVD Sales Surpass 400K*

According to figures released by eBrain Market Research, a service of the Consumer Electronics Association (CEA), total video sales in April moved up 6 percent over the same period last year. Shipments from manufacturers to dealers reached 4.9 million units in the month, while the first four months' sum reached 18.2 million units, representing an increase of 17 percent over 1999.

Direct view analog TVs and analog projection TVs both showed gains of 8 percent in the month. Year-to-date sales for direct view sets are up 11 percent to 6.9 million units. Direct view televisions measuring 29 inches and larger now account for 15 percent of that figure, and the 1.1 million large screen sets represent sales levels 31 percent higher than last year. Projection television sales are up 30 percent in the year-to-date.

"Consumer interest in video technologies has never been higher and we have a great dynamic going on at retail. Shoppers are snapping up great VCR bargains, they're adopting new technologies like DVD, and of course they continue to upgrade their TVs at a record pace," noted CEA Vice President of Market Research Todd Thibodeaux.

The largest percent increase in April belongs to TV/VCR combinations. Sales in this category grew 26 percent in the month, leaving the year-to-date 20 percent higher than 1999 with shipments nearing 1.4 million units so far this year.

Camcorder sales, so far this year, are up 17 percent to 1.6 million units. And, thanks to a spectacular final week, DVD player sales in April exceeded 400,000 units, putting this rapidly growing digital category also at 1.6 million units for the first four months of the year.

eBrain Market Research is a service of CEA. eBrain is smarter research, providing the most comprehensive source of sales data, forecasts, consumer research, international research, and historical trends for the consumer electronics industry.

## Over-the-Air Video Programming Should Remain Focus of DTV Transition, Says CEA

Ensuring that today's viewers continue to enjoy free, over-the-air service should be the primary focus of the digital television (DTV) transition, said the Consumer Electronics Association (CEA) in comments filed with the Federal Communications Commission (FCC). While new services should be "permitted and encouraged," argued CEA, they should be consistent with broadcasters' "continued delivery of free over-the-air programming in the digital era."

"Broadcasters should have the freedom to invest in and provide new services to viewers such as datacasting and interactivity," said CEA President and CEO Gary Shapiro. "Indeed, our research shows consumer interest in these functions. But these potential new services must not prevent or inhibit consumers from receiving free, over-the-air programming in the digital age nor should these services be used as a foil to push non-compatible changes to the DTV transmission standard or otherwise delay the transition."

In its comments, CEA also reiterated its opposition to modifying the existing DTV transmission standard, arguing that doing so will create uncertainty and delay in the marketplace, ultimately harming consumers. CEA expressed its confidence that current testing of the FCC-approved 8-VSB modulation standard — if fair and objective — will reveal yet again that the standard is suitably robust for broadcast television, noting that there is no consensus nor valid reason to consider to modify or replace the current standard.

"Our members also have indicated to us that the standard is capable of accommodating changes in order to meet new needs as they are identified, and doing so in a fully backward compatible manner," wrote CEA. "Clearly," CEA continued, "use of the extensible features of the DTV standard to meet new needs is far superior to adopting a new non-compatible standard. Introduction of a non-compatible standard would harm consumers by dividing the broadcast marketplace, impairing the utility of existing receivers, and increasing the cost of all new receivers."

CEA went on to question the motivations of Sinclair Broadcasting, the principal champion of modifying the existing standard. CEA noted that Sinclair's financial interest in broadcast transmitter manufacturer Acrodyne Communications Inc. raises serious questions regarding the company's misinformation campaign regarding 8-VSB. CEA specifically pointed to a press release from Acrodyne, quoting from the release in its FCC filing, "The delay in conversion from analog to digital has given [Acrodyne] the opportunity to reposition the company from a niche to a mainstream supplier of transmission equipment and services."

"Of course," CEA pointed out, "the press release fails to disclose that the delay in the DTV transition that created this business opportunity for Acrodyne and Sinclair, is being spearheaded by Sinclair through its anti-VSB campaign."

"If successful in repositioning and reviving Acrodyne's analog transmitter sales, it appears that the delay and confusion in

*(Continued on page 62)*

# High-definition television antennas

by John A. Ross

The recent introduction of high-definition television (HDTV) to consumer markets has prompted the renewal of an old acquaintance for technicians. As noted in past articles about HDTV, many consumers will purchase outdoor antennas specially designed for the reception of HDTV signals. This article provides an overview of general antenna theory, an analysis of the HDTV transmission scheme, and a look at several antennas advertised for digital television signal reception.

### General information about antennas

An antenna designed for receiving signals must capture as much electromagnetic energy as possible to remain effective. Selecting an antenna depends on the application, location, and the path that the signal follows from transmitter to receiver. Antenna performance depends on the shape of the transmitted signal field, the capability of the antenna to reject adjacent signals, and the bandwidth of the antenna. Antenna designs range from the simple dipole to the more complicated yagi, helical, and satellite antennas. The latter designs include additional elements that add more shape to the radiated field.

With all this, the receiving antenna operates as a transducer and converts the electromagnetic energy picked up from space into signal energy consisting of voltage and current. Signals radiated from a transmitting antenna may take the form of a ground wave that follows the contour of the earth's surface, a space wave that travels along a direct line of sight to the receiver, a sky wave that radiates towards the atmosphere and bounces back to the receiver, or a satellite wave that travels from the transmitting antenna into space and beyond the earth's atmosphere. In each instance, the signal waves become affected by different circumstances, such as refraction, attenuation, reflection, diffraction, and path loss.

Ross is a technical writer and microcomputer consultant for Ft. Hays States University, Hays, KS.

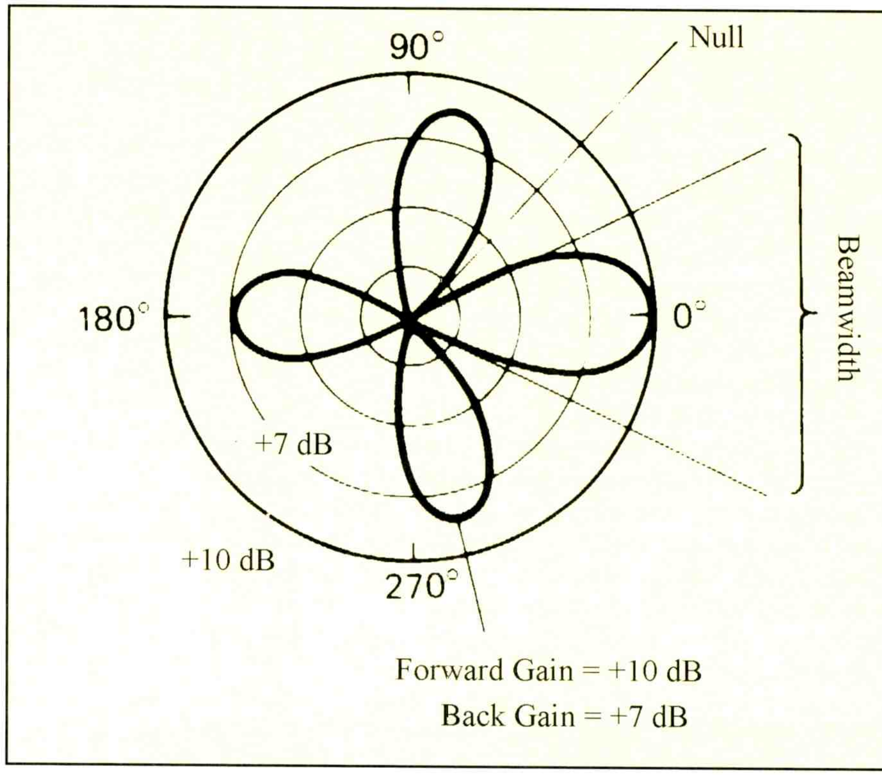


**Figure 1.** Antennas have characteristic transmission/reception patterns, as shown in this antenna pattern drawing.

Figure 1 depicts the radiation pattern of a signal and shows the effect of the pattern on gain, beamwidth, and the front-to-back ratio. The radiation pattern shows the general shape of signal intensity in all directions. Shaping the antenna field pattern for a receiving antenna produces higher effective power in the direction of the intended receiver. Power concentrates in the correct direction for the energy-collecting capability of the antenna. As a result, the antenna becomes more sensitive to the direction of the transmitting antenna.

### Antenna gain

If we compare the total signal output of a receiving antenna with the input power at the transmitter, no difference exists. Rather than produce gain in the same manner as an amplifier, an antenna produces gain through the shaping of the radiated field pattern so that power measured at a specific location is of a given level. In some instances, gain measurements for an antenna occur relative to an ideal isotropic reference antenna that radiates power equally in all directions over a perfectly spherical pattern. However, the ideal isotropic antenna does not exist in practice. Because of this, most antenna gain measurements are performed with respect to the power radiated by a half-wave dipole reference antenna.

### Antenna beamwidth

As Figure 1 indicates, antenna patterns have lobes that represent segments of very high signal strength and nulls that represent segments of very low signal strength. The beamwidth of an antenna equals the total angle at which the relative signal power remains not less than 3dB below the peak value of the main lobe. While beamwidth for special antennas can range from 1 to 360 degrees, most antennas have a

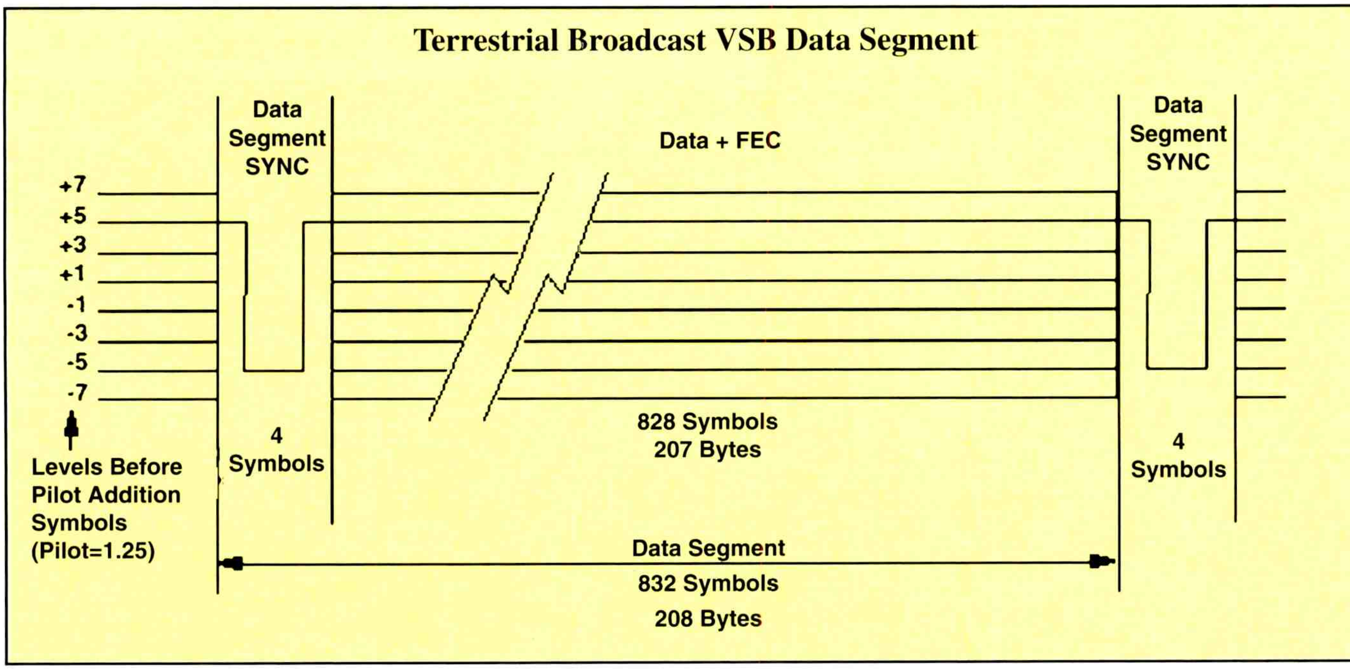


**Figure 2.** The digital television transmission standard takes advantage of the 8-Vestigial Sideband (8-VSB) modulation format and the MPEG-2 (Moving Picture Experts Group) compression/packetization format. The digital transmission standard allows the conversion of high definition studio video into the form used for over-the-air transmission.

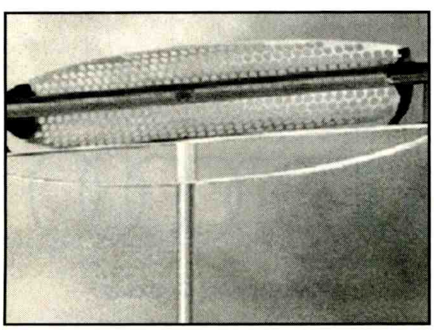

**Figure 3.** The HDTV60 from Terk is a high-performance antenna engineered for maximum reception of HDTV broadcasts. The HDTV60 is a broadband helical antenna with a unique coiled reception element that allows for a compact design while providing the power of a larger antenna.

beamwidth that measures in the 30 to 60 degree range.

### Antenna front-to-back ratio

Again referring to Figure 1, antennas have directivity when comparing the capability to capture signals from one or more locations. Directivity measures the signal strength from the desired forward direction and the signal strength of the backward direction. The front-to-back ratio compares the two measurements, yields a front-to-back power rating in decibels, and illustrates the directivity of the antenna. As an example, an antenna with a gain of +3dB in the front direction and -3dB in the back direction will have a front-to-back ratio of 6 decibels.

Every antenna has a physical design and dimensions that create optimum performance at a specific frequency called the center frequency. While some antennas perform well at frequencies other than the center frequency, the performance of other antennas decreases dramatically away from the center. The bandwidth of an antenna measures antenna performance at the 3 dB points from the center frequency. In mathematical terms, antenna bandwidth appears as the ratio between the highest and lowest frequencies found at 3 dB down frequencies.

Bandwidth requirements depend on the application. Wide-bandwidth antennas usually have less gain and less directivity than narrow bandwidth antennas. In addition, narrow bandwidth antennas reduce adjacent channel interference and received noise power. However, wide bandwidth antennas enable the reception of a larger band of signals.

### Digital television and antenna construction

Digital television broadcasters take advantage of unused UHF channels and taboo NTSC channels while utilizing an ATSC (Advanced Television System Committee) system that defines two vestigial sideband (VSB) modes. As illustrated in Figure 2, the digital television transmission standard takes advantage of the 8-Vestigial Sideband (8-VSB) modulation format and the MPEG-2 (Moving Picture Experts Group) compression/packetization format. The digital transmission standard allows the conversion of high definition studio video into the form used for over-the-air transmission.

Through the use of Reed-Solomon forward error correction, the trellis coded 8-VSB, and 1/6 data field interleaving, the terrestrial broadcast system withstands white noise and interference. For example, terrestrial HDTV broadcasts can operate in a signal-to-white noise environment of 14.9dB. To maximize service area, the terrestrial broadcast mode also incorporates both an NTSC rejection filter in the receiver. When the NTSC rejection filter activates, the trellis decoder switches to a trellis code corresponding to the encoder trellis code concatenated with the filter.

As mentioned, ATSC terrestrial broadcast applications rely on Trellis Coded Modulation, or TCM. During operation, the 8-VSB single-carrier modulation system delivers 19.29 megabits of data per second within a 6 MHz channel, establishes the basic band shape of the VSB signal, and suppresses the lower sideband. The serial data

**Table 1 — HDTV Antennas and Specifications**

| Company | Model Number | Construction | Usable Range | Operating Bandwidth | Gain |
|---|---|---|---|---|---|
| Channelmaster | 4251 UHF Antenna | Parabolic | UHF: 60+ Miles | UHF<br>470 MHz to 806 MHz | |
| Channelmaster | 4221A | 4-bay Bow | UHF: 45 Miles | UHF<br>470 MHz to 806 MHz | |
| Channelmaster | 4248 UHF Antenna | Yagi | UHF: 45 Miles | UHF<br>470 MHz to 806 MHz | |
| DX Communications | DTA-2000 Outdoor VHF/UHF/HDTV Antenna | Stainless Steel Elements and Integral Diplexer | VHF: 45 miles, conditions permitting<br>UHF: 45 miles, conditions permitting | VHF Low:<br>40 MHz to 108 MHz<br>VHF High:<br>170MHz to 230 MHz<br>UHF<br>470 MHz to 862 MHz | |
| Terk Technologies | TV-55 Indoor/ Outdoor VHF/UHF/HDTV Antenna | Helical coil broadband antenna element and dual-mode amplifier | VHF: 40 miles, conditions permitting<br>UHF: 40 miles, conditions permitting | VHF Low<br>54 MHz to 108 MHz<br>VHF High<br>170 MHz to 216 MHz<br>UHF<br>470 MHz to 806 MHz | +10dB |
| Terk Technologies | HDTV-60 | Broadband helical antenna with a coiled reception element | VHF: 50 miles, conditions permitting<br>UHF: 50 miles, conditions permitting | VHF Low<br>54 MHz to 108 MHz<br>VHF High<br>170 MHz to 216 MHz<br>UHF<br>470 MHz to 806 MHz | +10dB |

stream consists of 188-byte MPEG-compatible data packets. During signal processing, the data randomizer operates on the remaining 187 data bytes of each MPEG packet after the removal of the sync byte from the signal.

An antenna operating frequency and signal wavelength determines the physical size of the antenna elements. As Terrestrial Digital/HDTV broadcasts become more prominent, UHF antennas will play a larger role because the majority of the HDTV/Digital channel allocations will be in the UHF frequency band. Table 1 provides a listing of several currently available HDTV and digital-compatible antennas along with specifications for those antennas.

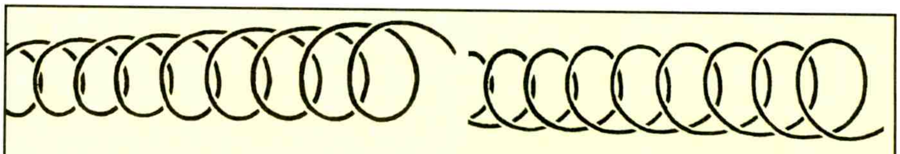


**Figure 4.** Helical antenna design operates on the principle of circular polarization as shown here, rather than the horizontal or vertical polarization found with other antenna designs.

### Advanced multiple element antennas

Each of the antennas listed in Table 1 provides specific characteristics necessary for operation with digital television broadcasts. The Channelmaster antennas utilize arrays to shape the radiation pattern of the antenna field. Going back to our preliminary discussion about antennas, the shaping of the pattern sharply focuses the antenna and increases the apparent power in a given direction. The array also provides a higher front-to-back ratio and decreases adjacent channel interference by reducing the sidelobes.

An antenna array consists of an active element, powered element, a director, and a reflector. With the transmission line connected to the powered element, the director and reflector distort the radiated field pattern. The Yagi array seen with the Channelmaster Model 4248 antenna utilizes additional directors to increase gain and sharpen the main lobe. Yagi arrays produce a radiated pattern with a large main lobe and small minor lobes. Front-to-back ratios for Yagi arrays range from 15dB to 20dB.

Pictured in Figure 3, the Terk Technologies model HDTV-60 antenna relies on a helical design to achieve desired performance. The helical design operates with the circular polarization shown in Figure 4 rather than the horizontal or vertical polarization found with other antenna designs. Going back to Figure 3, the helical antenna uses a driven element wound like a screw thread. The field radiates along the axis of the helix.

Helical antennas offer a broad beamwidth that ranges from 20 to 90 degrees and a narrow bandwidth of +/- 20 percent of the center frequency. The diameter of the helix and the diameter of the wire or tubing used for the helix determine the bandwidth of the antenna. Along with providing good gain characteristics, helical antennas feature easy alignment. Helical antenna gain depends on the diameter of the helix, the number of turns in the active element, the amount of spacing between turns, and the wavelength. ■

# Servicing tips for the RCA CTC187 chassis

By Homer L. Davidson

When the symptom is a dead set, or a set that is in shutdown, the most likely cause is a defective component(s) in the low-voltage or high-voltage power supply circuits. A dead chassis might result from a defective regulator, or diodes and transistors in the low-voltage circuits. A shorted or leaky horizontal output transistor or poor connections on the horizontal driver transformer might result in high voltage shutdown or a dead chassis condition (Figure 1).

The power line fuse usually blows when a diode or regulator in the low-voltage power supply becomes leaky or shorted. If a defective component in the secondary circuits of the low-voltage power sources was the cause of the problem, however, the fuse might not have blown. Likewise the condition of the fuse, blown open, or normal, might help you determine what section of the low voltage circuits are defective.

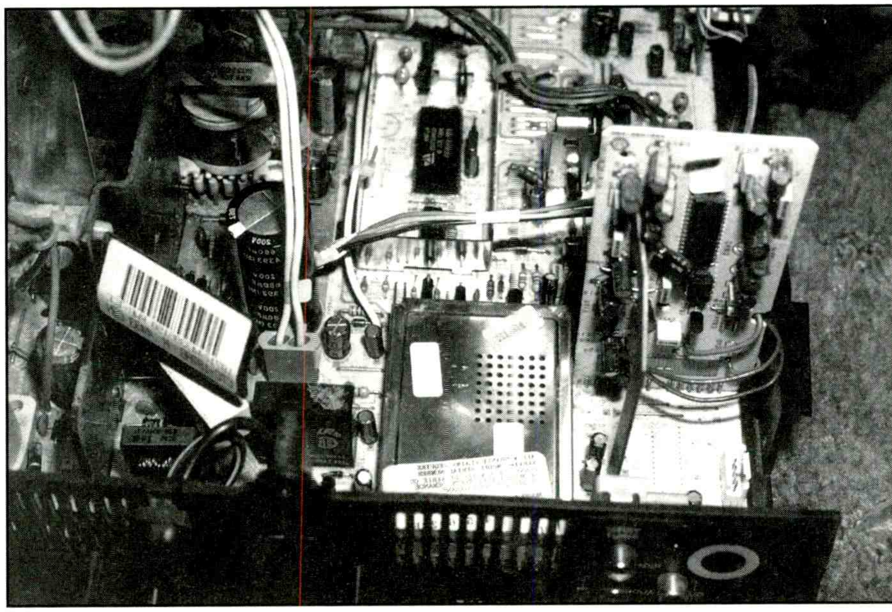

**Figure 1**. Locating defective components in the latest RCA TV chassis might be more difficult because of the cramped quarters.

### EEPROM problems

Before tackling either the high-voltage or low-voltage circuits in the case of a dead or shutdown chassis, check the EEPROM IC (U3201). This IC is the cause of many different troubles in the CTC187 chassis. If the EEPROM is defective, the chassis may turn on immediately when the set is just plugged in and you won't be able to turn it off until you unplug the ac cord. If the set is dead but the fuse is intact, the problem may be caused by a defective U3201. In some cases, you'll find that the EEPROM IC must be replaced after other repairs are made.

Another possible symptom of a defective EEPROM is absence of raster even though the CRT filament is lit and HV is present. Absence of audio, or low volume accompanied by lack of video can be the result of a bad U3201. A very dark picture, intermittent snow, bright screen with retrace lines, and no video with normal audio can be caused by a defective EEPROM IC. A no raster symptom, except on-screen display, can result from a defective EEPROM. A bad soldered joint at the horizontal output transistor heat sink-ground tab can cause repeated failure of the EEPROM.

Also, a bad EEPROM can cause a snowy picture, vertical jumping, and weak audio. The TV may not receive all channels if the EEPROM is defective. All cable channels and 7–13 might not be received or have intermittent reception with a bad EEPROM IC. Sometimes the channels cannot be changed.

Different screen colors, such as a green faded picture, red horizontal line in the center with no vertical sweep, lines on the screen and out of horizontal sync can be caused by U3201. The EEPROM IC can cause on-screen display shifted partly off screen, channel numbers to the far right of screen, missing display of volume, color, and tint. When ordering out an EEPROM replacement (U3201), make sure of the correct part number, model, and chassis number of RCA TV, as there are several different replacements. U3201 is connected to pins 19 and 20 of the Control Micro (U3101) (Figure 2).

### Dead chassis-fuse blown

If the set is dead, and the fuse has blown, suspect defective components in the low-voltage circuits. Any of a number of problems can cause fuse F4001 (5A) to open: a shorted or leaky CR4001, CR4002, CR4003, or CR4004 in the low voltage power supply. Although regulator U4101 is in the primary winding, a leaky regulator IC might not blow the line fuse.

If you hear a high-pitched squeal when the set is plugged in but not turned on, replace C4103 off of pins 3 and 6 of U4101 (Figure 3). The squeal might disappear when the set is turned on. A dead chassis with a normal fuse might be caused by a defective regulator (U4101).

If the set doesn't produce a raster, check resistor R4104 (1.5MΩ) to see if

Davidson is a TV servicing consultant for **ES&T.**

## ES&T Calendar

September 6–10, 2000
CEDIA Expo
Indianapolis Convention Center
Indianapolis, IN

Custom Electronics Design and Installation Association (CEDIA)
9202 N. Meridian #200
Indianapolis, IN 46260-1810
800-669-5329
www.cedia.org

August 7–12, 20000
NPSC (National Professional Service Convention)
John Ascuaga's Nugget Hotel
Sparks (Reno), NV

National Electronics Service Dealers Association (NESDA)
2708 West Berry St.
Ft. Worth, TX 76109

COMDEX
September 26–28, 2000
Miami Beach Convention Center
Miami Beach, FL

COMDEX
300 First Avenue
Needham, MA 02492-2722
781-433-1500
www.zdevents.com/comdex

October 15-17, 2000
AFSM International 30th World Conference and Exposition
Opryland Hotel
Nashville, TN

January 6–9, 2001
International Consumer Electronics Show (CES)
Las Vegas Convention Center, Sands Convention Center and various hotels
Las Vegas, NV

Consumer Electronics Association
2500 Wilson Blvd.
Arlington, VA 22201-3834
703-907-7600
Fax: 703-907-7602
www.cesweb.org


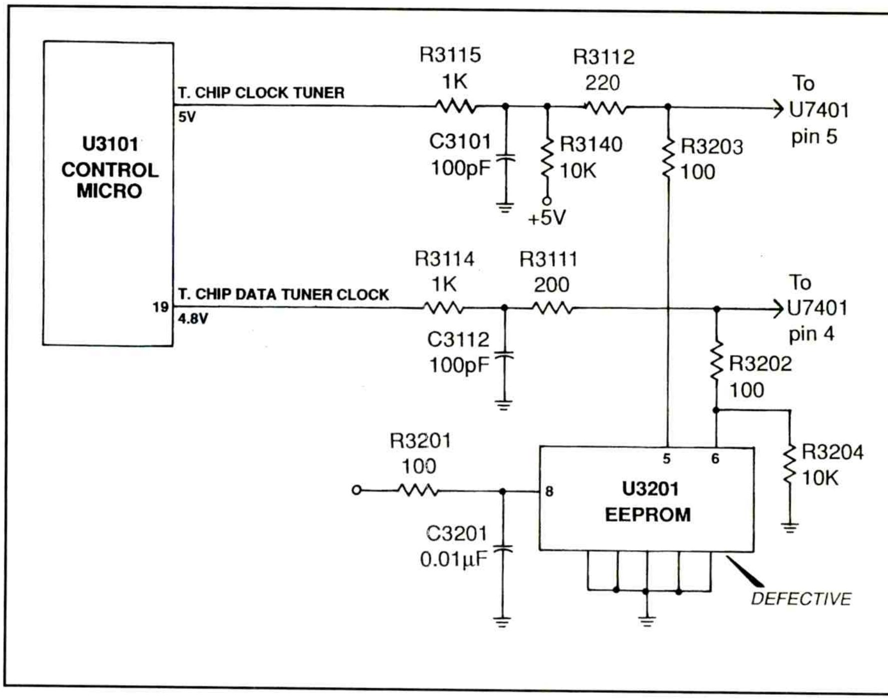


**Figure 2**. A defective EEPROM can cause many different service symptoms in the RCA CTC177 and CTC187 chassis.

its resistance has changed. Notice that the primary circuits of the switching power supply are not referenced to ground and the secondary circuits of the low-voltage circuits are at common ground.

If the set is dead, and the fuse is intact, suspect one of the following problems:

• leaky diodes and transistors in the secondary circuits of T4101,

• CR4106

• a leaky standby transistor Q4105 (+5V STBY).

### Dead chassis-normal fuse

In one set that I'm aware of, a broken trace feeding 12V to the Control Micro (U3101), at a 5.1V zener diode (CR3111), caused the symptom of a dead set with the fuse intact. Measure the 12.1V source at the collector terminal of CR3111. Suspect an open trace line or poor soldered connection at this

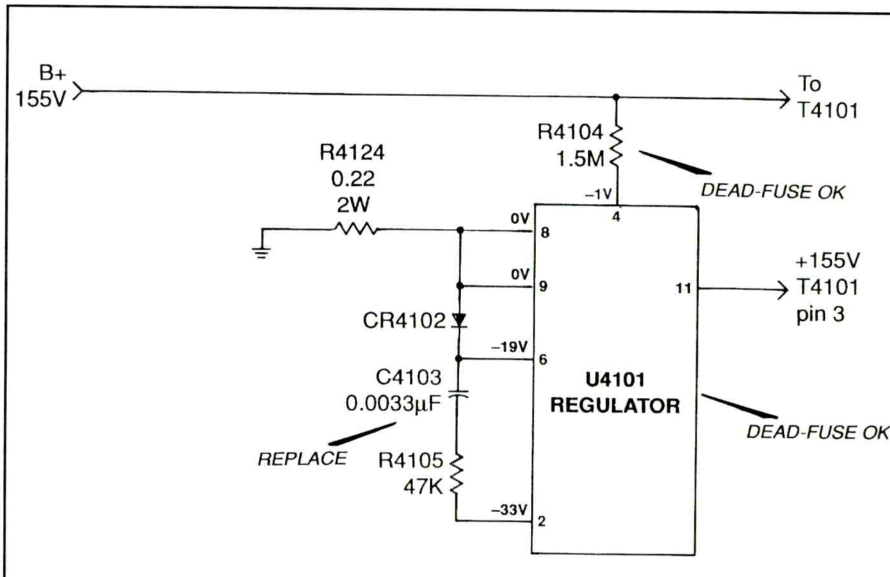


**Figure 3**. A dead CTC187 chassis with normal fuse might be caused by a component around the U4101 regulator IC.

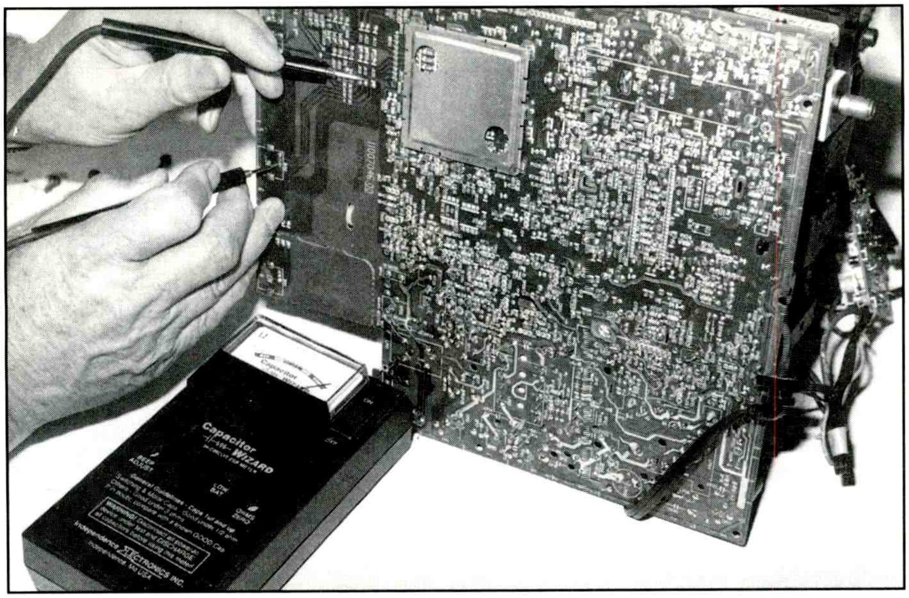

Figure 4. Check for open or soldered trace line in the TV chassis with the ESR meter.

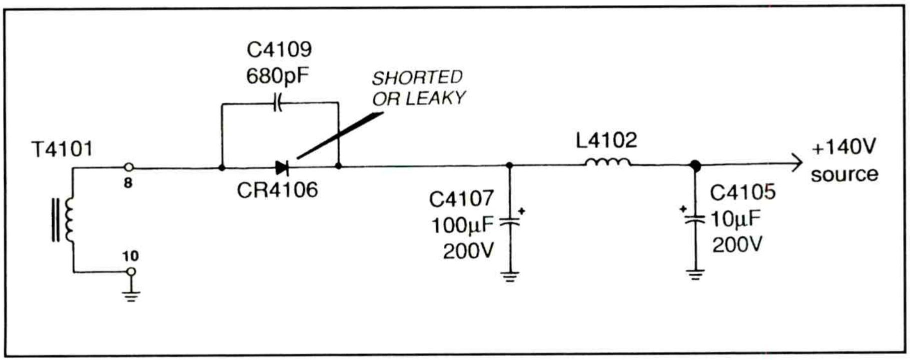


Figure 5. Check CR4106 in the +140V source and Q4105 in the +5V standby source when the problem is a dead chassis.

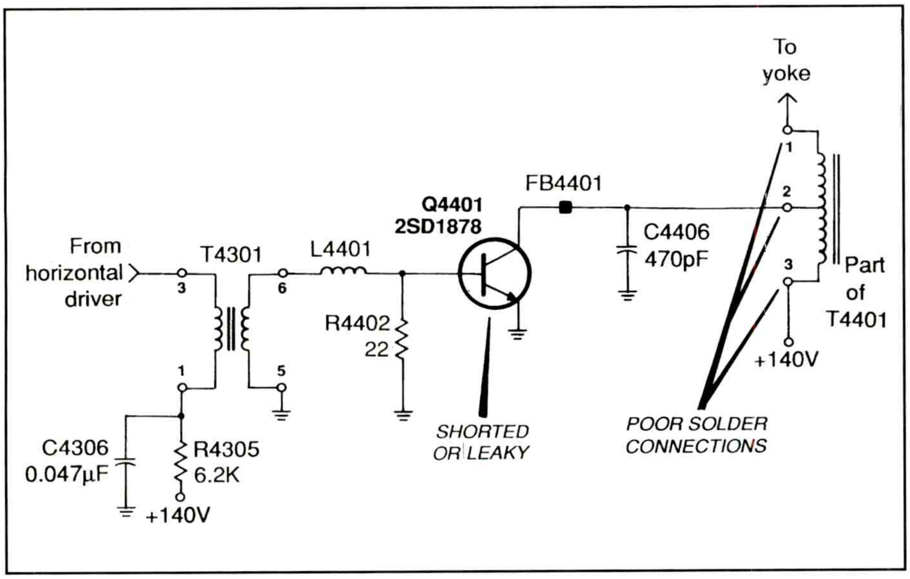


Figure 6. Resolder pins 1, 2, 3, and 10 of flyback (T4401) if the chassis is dead and you hear a whining noise.

voltage source. Discharge the 12V source and check for an open foil or connections with the ESR meter. Check for continuity of the trace line from the 12V source to CR3111 (Figure 4).

Defective transistors and diodes in the secondary winding of T4101 can cause a dead chassis with a normal fuse symptom. Leaky Q4105 (+5V standby) transistor has been known to break down and result in a dead chassis. This +5V source feeds the Control Micro (U3101), reset, tuner control, and EEPROM (U3201) circuits.

Check the +140V source feeding the flyback and horizontal output transistor for low or no voltage. A shorted or leaky Q4401 can damage diode rectifier CR4106. Often the line fuse will not open when a component in the secondary voltage sources fail. CR4106 rectifies the voltage developed in the switching power supply and is fed to the +140V source. The +140V source feeds the horizontal output and flyback circuits (Figure 5).

### Dead chassis-old faithful

If you encounter a CTC187 with a dead chassis and you hear a whine or sound from the SMPS power supply, suspect a leaky horizontal output transistor (Q4401). Sometimes the set will produce audio, while at other times there will be no audio. You might find that other components have become defective if the output transistor is damaged. If you replace Q4401 because it is leaky or shorted, replace U4101 as well. Replace defective Q4401 with exact replacement (191142), when possible. If the original replacement is not available, replace with a universal replacement. If you measure 0V at the horizontal output transistor, the cause may be poor soldered joints at T4401, on terminals 1, 2, and 3.

A flyback that's shorted, or arcing, might be the cause of an open fuse in a dead CTC187 chassis. If the chassis is dead and you hear a whine coming from the switched mode power supply, the cause may be a leaky horizontal output transistor (Q4401) and/or poor soldered joints on pins 1, 2, 3, and 10 of the flyback (Figure 6). Resolder all flyback terminals and check from each of the resoldered terminals to the component to which it's connected on the foil or trace line. Sometimes the foil will break or a poor soldered connection results at trace and pin terminal connections.

Poor soldered connections of pins 1, 2, 3, and 10 of flyback can also cause intermittent picture, snowy picture, and loss of vertical sweep. Intermittent loss of horizontal sweep and a vertical line in the center of the screen can be caused by poor soldered connections of pins 1 and 2 of the flyback (T4401). A leaky or arcing flyback can destroy the horizontal output transistor. The shorted flyback can cause the line fuse to open (Figure 7). Intermittent shutoff or failure to start-up can be caused by bad soldered connection on pin 3 of the flyback. Components C4106, Q4401, and U4101 are the causes of most problems in the CTC187 in which the set is dead but the line fuse is intact.

If the set will not power-up, or if it's dead, or shuts down intermittently, resolder all connections on the horizontal drive transformer (T4301). If there's no horizontal drive, check for a bad solder joint on R4134. Double check the resistance of the primary winding and resolder contacts. When the +140V source is not present on the primary winding, suspect a broken trace or poor soldered connections. Check for a broken foil connection on the primary winding with the ESR meter.

A bad soldered connection on the horizontal buffer transistor (Q4302) has caused a dead chassis. Resolder all transistor terminals on PCB. If no drive pulse is found at the emitter terminal of Q4302, suspect a broken foil from the +12.1V source to the collector terminal. Check for poor board or broken foil connection with the ESR meter. Remember the horizontal circuits must perform before any voltages are found in the secondary circuits of the flyback (T4401).

### Dead-no vertical sweep

If the chassis is dead and there's no vertical sweep, check CR4704, Q4101, and R4702. Regulator Q4101 supplies 7.5V to the vertical circuits of U1001 T chip. A no vertical sweep or audio symptom might be caused by a intermittent or open CR4701 (Figure 8). A shorted CR4704 and burned R4702 (2.2Ω) off of pin 9 of the flyback can produce a dead symptom. Suspect a bad soldered joint at microprocessor shield grounds, when the vertical drops down from the top of the picture. Intermittent vertical sweep can be caused by bad soldered joints on the flyback; resolder terminal pins 1, 2, 3, and 10 of the flyback.

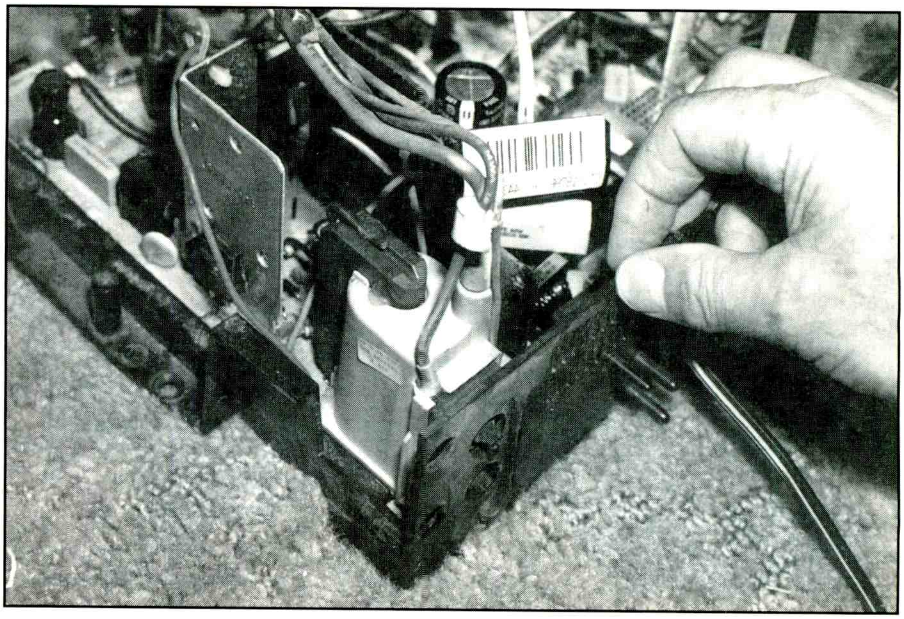

**Figure 7**. Bad soldered connections on the flyback terminals can cause intermittent raster and picture, and sometimes, when arcing, can open the power line fuse.

### RCA CTC187-narrow width

Although defective components in the horizontal output circuits might not necessarily cause the chassis to appear dead or shut down, shorted CR4403 and C4407 can produce a narrow width picture and bowed raster. Repeated failure of CR4403 can be caused by C4407 (0.047μF), which is connected in parallel with CR4403.

In the case of one set with narrow width, the input drive waveform observed on the oscilloscope was quite adequate, with little increase in collector voltage of Q4401. Q4401 tested normal with in-circuit tests. The supply voltage at the flyback was discharged and the ESR meter was used to check the hold-down, or safety, capacitors.

The capacitance of C4406, connected to the collector terminal of Q4401 could not be tested accurately in-circuit using the ESR meter. Capacitor C4402

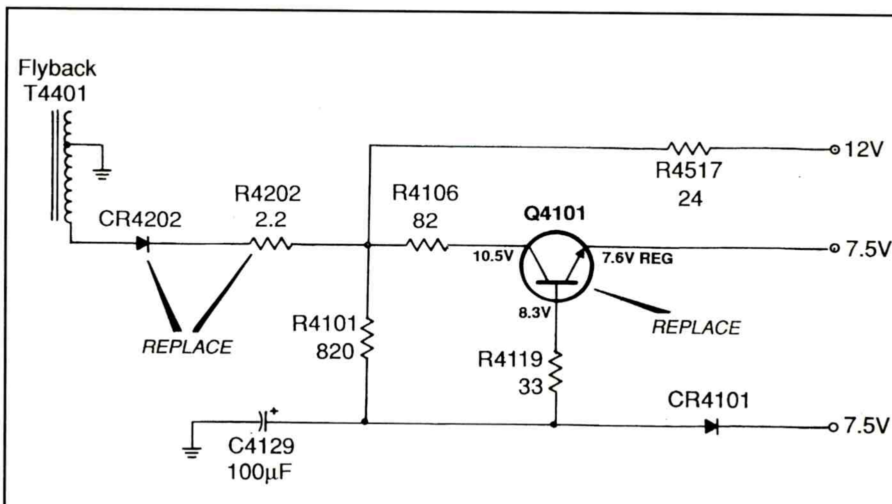


**Figure 8**. Check CR4704, Q4101, and Q4702 in the 7.5V source if the chassis is dead.

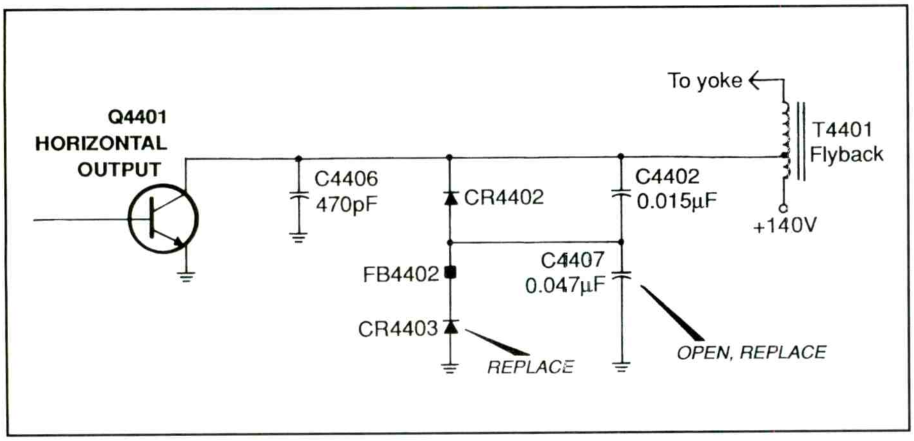


**Figure 9**

(0.015µF) tested normal. A number of sets using these same safety capacitor circuits exhibited this problem. In most cases capacitor C4407 (0.047µF) was found to be open. Moreover, even though CR4403 appeared to be in good condition, the sets could not be made to operate properly until this component was replaced. I recommend that any time you replace C4407 because it's defective, you automatically replace CR4403 as well. CR4403 and C4407 can produce a narrow width picture with the sides bowed inward (Figure 9).

Before leaving this horizontal circuit, check C4404 (2.2µF), C4403 (0.43µF), and C4402 (0.015µF); capacitors that can cause yoke circuit problems, using the ESR meter.

In the case of a picture that is bowed in from both sides of the raster, suspect a defective component in the pincushion circuits. Check for a leaky pincushion transistor (Q4851) and leaky CR4403 in the main PCB.

### Lightning damage

Lightning or a sudden power surge can destroy components in the low voltage power supply. When you think that one of these sets has been exposed to excessive voltage caused by lightning or some other type of power surge, suspect damage to F4001, L4001, CR4001, CR4002, CR4003, and CR4004 in the low voltage circuits. Double check voltage regulator U4401, CR4112, and CR4109 in the switching power supply circuits. The amount of damage might depend on how close to the customer's home the lightning strike occurred.

If excessive voltage is applied to the power supply of the TV chassis, it might destroy the Control Micro (U3101) and EEPROM IC (U3201), in addition to those parts listed above. If the surge was of high enough voltage, you might find extensive copper trace damage to the PC board. If the damage is serious enough, it might not be economically feasible to repair the set. ■



# The Dolby systems

**By Alvin G. Sydnor**

It was October 1967 that I attended the Audio Engineering Society (AES) Convention that was held at New York's Barbizon-Plaza Hotel where there were about thirty exhibitors displaying their wares. It was during these four days that I was first exposed to Dolby Labs and had the pleasure to meet and talk with Ray Dolby who was demonstrating his new noise suppression system in his hotel room rather than the exhibit hall.

One year later, in November 1968 Dolby introduced his Duplicator Noise Reduction System Model 340, which was a special version of the model A-30T system. This new system was designed to replay noise-reduction tapes at the high speeds that were used in the mass production of pre-recorded reel-to-reel and eight-track tapes. At that time, recording companies were using state-of-the-art techniques in high-speed duplication. The noise level build-up on the duplicate was often limited by the build-up of noise in the several tape generations proceeding the final one. The model 340 was designed to provide a way of effectively eliminating the noise contribution thus resulting in a superior quality "first generation" duplicate.

A recording company that used the Dolby system and wanted to issue a pre-recorded tape of a particular performance could do so in two different ways. If the master was made with the Dolby A-301 system, a copy of the master could be made through another A-301 in the "compressed" mode.

If the master tape was made by conventional means, it still could be copied through the A-301, also in the "compressed" mode. The "compressed" tapes are sent to the duplication plant where a high-speed dubbing master is made with an A-301, the dubbing master still being in the "compressed" mode.

In the duplication process, playback signals from the high-speed tape reproducer are processed by the model 340 and restored to normal; the signals are then fed to the high-speed slave recorders in the usual way. Since the slave recorders are receiving a signal that is the equivalent of that from the original master, the commercial pre-recorded tape is in essence a first generation tape. The A-301 system provides a full 10dB reduction of print-through and a 10dB to 15dB reduction of hiss.

Sydnor is a retired consumer electronics servicing technician.

### The nature of noise

It is a known fact that all noise is caused by real physical disturbances, and noise cannot ever be completely removed. The amount of noise heard by a listener depends on certain conditions, some of which can be controlled in reducing noise.

In magnetic tape recording, the predominant noise heard is that produced by the tape itself, which is called tape-noise or hiss. Tape noise or hiss is the result of the nature of the magnetizing particles coated on the tape. When recording loud passages, more magnetic particles are magnetized. When the sound is soft (low), fewer magnetic particles are being magnetized. Because the number of magnetic particles will vary slightly from one place on the tape to another, the intensity of the overall recording cannot be made perfectly uniform. When playing back a tape there will be a slight fluctuation of loudness, which is a steady hiss that is superimposed on the recorded program. This is much more noticeable during quiet passages or intervals of low-level music passages.

Those who have been associated with audio recording may say; "If I increase the recording level and reduce the playback level I will have reduced the noise level." This is true, but the effectiveness of this approach to noise reduction is limited because you will eventually reach a point where you cannot increase the recording level any higher.

Most of the disturbing noise on a tape recording is in the high-frequency range, which led to recording high-frequency signals at an increased level, thus attenuating them during playback. This is what we call "equalization" and the technique works because high frequency portions of the program are normally at lower levels than other parts of the original program, and there is not much danger of saturating the magnetic particles on the tape. This is only a statistical truth. It is because of equalization that loud cymbal crashes or other passages that have loud high-frequency sounds are distorted even on the best recordings.

One method recording engineers used to reduce this effect was to position the musical instruments at a distance from the microphones.

### Dolby noise reduction system

The Dolby noise reduction system takes advantage of psychoacoustic phenomena in a way that enables a substantial reduction of noise without any other audible effect on the program material. The inherent nature of the system is a very reliable method of electronic control. Any recording or broadcast made using the Dolby system can be played back or received through a Dolby system or conventional means not using the Dolby system.

For more than 50 years, many researchers have been investigating the psychoacoustic effect, which is more commonly known as "masking," by which a louder sound cancels from the listener the presence of a different, softer sound. This effect plays a very important part in the operation of the Dolby noise reduction system.

Noise is only disturbing to the listener when the program level is low enough to permit the noise to come through and be heard. As an example, a trombone playing at high volume will mask the sound of a tambourine being played softly at the same time, thus we have noise along with the softly playing tambourine.

One important peculiarity of the masking effect is that it does not occur when the two sounds concerned are of different pitch. So, while we can say that a trombone may mask the sound of a tambourine, even a very loud note of a bass drum will not, because the tambourine and bass drum are so different in pitch. This same effect occurs with the masking of noise during playback of tape recordings and even FM broadcasts, because much of the noise heard is high-pitched noise in the form of a steady hiss. The noise is more easily masked by high-pitched sounds than bass notes.

As discussed earlier, increasing the recording level and reducing the playback level can be used to reduce noise but it has its limits. As an example, in disc recordings a maximum level is soon reached where the grooves begin to run into each other and in FM broadcasting, the limit is the point at which over-modulation (excessive deviation) occurs.

After more than 35 years, Dolby has become a household word and today Dolby Laboratories has more than 18 professional audio products all designed to enhance the quality of audio recording and reproduction. We will not attempt to cover all versions of the Dolby systems here. The purpose of this article is to present the basic introduction of the Dolby system.

### The two Dolby systems

Basically there are two Dolby systems; the "A" system was designed for professional use in suppressing noise, hum, and other disturbances over the entire audio frequency range. The "B" system is a much-simplified system that was designed specifically to reduce noise in broadcast and recordings for use in home recording and playback equipment. The complete B system has been incorporated within many home recording and playback systems.

The Dolby system integrates the ideas of masking and automatic level control. The system automatically increases the recording or broadcast level of quiet musical passages that could not mask noise, and then reduces the level of the same passages during reception or playback. In the process, the original sound is exactly restored, but the noise, which would otherwise be audible, is reduced to a point of not being heard. The encoding during broadcasting or recording and the decoding during playback are all accomplished by circuits that are nearly identical, and in fact the circuits can perform either encoding or decoding if appropriately wired or switched. The system analyzes the program so quickly as to make its operation inaudible, and noise is suppressed without changing any other program characteristics that can be heard.

Because the encoding process has no effect at all on the loud parts of the program, the system cannot cause excessive levels to be reached during recording or broadcasting. The effect on program material is so subtle that listeners who do not have decoding systems cannot tell that the program they are hearing has been processed in any way.

There are many listeners who believe that the program material has been improved over the original, especially when using inexpensive equipment. When the encoded signal is heard through wide-band equipment without Dolby circuits, it is noticeably brighter in overall sound quality, but if the treble control is adjusted very slightly this effect disappears. So we can say that the system is compatible in the sense that it does not require that the listeners own playback equipment with Dolby circuitry unless they wish to gain the advantage of superior noise reduction.

When talking about high fidelity, particularly in the early days of FM broadcasting, there was much discussion on the equalization being used in FM broadcasting, this was particularly true in the restricted level of the high-frequencies imposed by the standards. During the transmission of high quality recordings and live broadcast, it was necessary to artificially limit program levels. The use of stereo multiplex broadcasting had degraded reception considerably. Even the theoretical minimum increase in noise produced by stereo broadcasting was nearly 24dB per channel and this was accomplished only by the best circuits available at that time.

When SCA (subcarrier authorization) background music services began it was an economical necessity for the survival of FM stations and it imposed stiff technical requirements on tuners for home use. Many tuners never met the requirements. Tuners at that time often emitted high-frequency "chatter" when both SCA and stereo multiplex broadcasts were being transmitted. The use of the Dolby "B" system had a pronounced effect upon broadcast reception because of the system's highly effective noise reduction. When the broadcaster used the "B" system, home listeners using receivers equipped with decoders enjoyed a noise reduction of 10dB. This 10dB is the difference in level when power was changed by a factor of ten.

### Dolby noise reduction in movies

Throughout the years there have been many attempts to solve the problem of noise in audio systems, but there has not been a noise reduction technique that has been acceptable by the industry until Ray Dolby introduced his system. The Dolby system made its presence known within the movie industry in 1976 when the Dolby Stereo System first appeared in movie theaters, and in 1992 the movie "Batman Returns" used the Dolby Stereo Playback System. And as of today, there are more than 9,000 movie theaters equipped with Dolby Digital Playback systems.

# Photofacts

**GE**

| | |
|---|---|
| CTC187CN3 | 4329 |
| 31GT660YX1 | 4329 |
| 32GT660YX1 | 4329 |

**JVC**

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| AV-20120 | 4328 |
| AV-20121 | 4328 |
| C-20110 | 4328 |
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**PANASONIC**

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| CT-13R31B | 4327 |
| CT-13R31CB | 4327 |
| CT-13R41B | 4327 |
| CT-13R41CB | 4327 |
| MGP328 | 4327 |

**RCA**

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|---|---|
| CTC203AX | 4336 |
| F26645YX1 | 4336 |
| F27645YX1 | 4336 |
| G27646YX1 | 4336 |
| G27647YX1 | 4336 |
| TX825XB | 4332 |
| X13050GSF04 | 4332 |
| X13101GSC04 | 4332 |
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| X13101GSF04 | 4332 |
| X13101GSF24 | 4332 |

**SAMSUNG**

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**SANYO**

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| DS19590 | 4325 |
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| DS19590-01 | 4325 |

**SHARP**

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| 20VT-H60 | TVCR-324 |

**SONY**

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| SCC-J73C-A | 4326 |
| SCC-S27K-A | 4334 |
| SCC-S27L-A | 4334 |
| SCC-S28G-A | 4334 |

**TOSHIBA**

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**ZENITH**

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| A27A11D4 | 4330 |
| A27A12D | 4330 |
| A27A12D4 | 4330 |
| LGA20A02DM | 4335 |
| LGA20A02DM4 | 4335 |
| LGA29A11DM | 4330 |
| LGA29A11DM4 | 4330 |
| LGA29A12DM | 4330 |
| LGA29A12DM4 | 4330 |

In 1995, the Consumer Electronic Industries Digital Video working group were looking for the best audio coding technology available for the new DVD format. Dolby made its point very clear in that with their experience and knowledge in the movie industry and the expectation of their audio coding in the new digital TV standard made their system a natural for DVD. The DVD industry group selected the Dolby System as one of the two mandatory sound tracks for all DVDs released in the United States, which meant that at least one system has to be on each disc. The two-channel PCM soundtracks found on CDs was the other mandatory format.

During the past 45 years about one billion Dolby certified audio products sold. All products have received a real boost with the emergence of digital TV, DVD, and home theater systems, which has put a premium on all audio product quality.

### Dolby digital

Today, the Dolby Digital format (formally called AC-3) is the approved standard for encoding surround sound material on all DVDs, and today there are 5,000 DVD titles and more than 30 million products in use that incorporate Dolby Digital decoders which represent more than 600 different models from a number of different manufacturers.

In essence, the Dolby Digital coding scheme relies on a sophisticated "psycho-acoustic" model to compress the data. The basic principle is to code all of the sound that can be detected by the human ear with just enough resolution to ensure that no audible distortion or noise has been added. As an example, loud sounds can totally mask the presence of other lower-level sounds and noise that are nearby in frequency. It is therefore possible to use fewer bits to quantize the louder sound without any apparent audible side effects. This technique is known as perceptual coding and it will ensure that even though the delivered audio data is not exactly the same as the PCM original captured in the recording studio, the sound quality is perceptually unchanged.

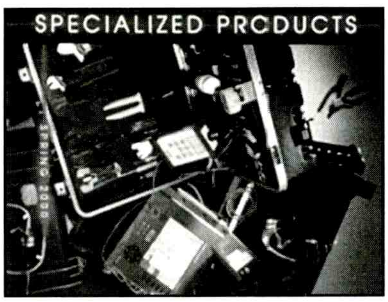
**NOTE:** Dolby© is a registered trademark of Dolby Laboratories. More detailed information about Dolby Systems is at www.dolby.com/tvaudio.

# Literature

### Fiber optic, telecom, cable tools and test equipment catalog

Specialized Products has released its new comprehensive Spring 2000 catalog. The 400-page publication features a wide assortment of the latest products for virtually every service application in the Telecom, LAN, Fiber Optic, Wireless, Medial Electronics, and Computer industries.

Technicians, field service managers, and engineers can choose from a complete assortment of electronics test equipment featuring component testers, digital multimeters, frequency counters, function generators, oscilloscopes, power supplies, and the largest selection of instrument/shipping cases in the industry. LAN test equipment choices include analyzers, Category 5 testers, continuity testers. The telecom selection includes bit error rate testers, digit grabbers, digital butt sets and transmission test sets. For fiber optic test equipment, choose from cleavers, light sources, optical time domain reflectometers, power meters, strippers and more. Any standard tool kit may be modified to suit a customer's specific application or budget. For more unique requirements, custom tool kits can be built from scratch to exacting specifications.




Specialized Products Company, 1100 S. Kimball Avenue, Southlake, TX 76092, Phone: 817-329-6647, Fax: 817-329-6195
**Circle (90) on Reply Card**

### Wire and tubing processing equipment catalog

A new full-color catalog features a wide range of wire and tubing processing equipment, including wire, cable, and tubing cutters of all types, lead wire and cable strippers, coaxial cable strippers, magnet wire strippers, infrared heating equipment, component forming tools, and fybRglass brushed and wire wheels manufactured by The Eraser Company, Inc.

Any unit can be designed to meet custom specifications including fybRglass brushed and wire wheels. The company's technical and engineering staff is available to assist in matching machines to the customer's application.

The Eraser Company, Inc., P.O. Box 4961/Oliva Drive, Syracuse, NY 13221-4961, Phone: 315-454-3237, Fax: 315-454-3090, Website: www.eraser.com, E-mail: info@eraser.com
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### Web page

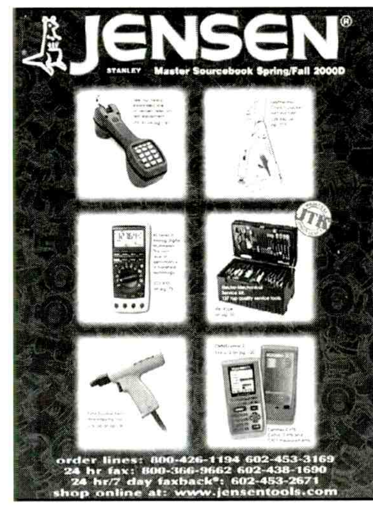
Electronics Design Specialists announces a service to all electronic technicians and engineering technicians: a special web page for technicians looking for, or wanting to sell test equipment or anything else electronics. Technicians may use this page as a clearinghouse to find that elusive out-of-production test equipment or to sell unwanted equipment. Those looking for a particular piece of equipment can also post their request. These services are free. Direct your browser to www.eds-inc.com and click on the Outlet Center link.

Electronic Design Specialists, 4647 Appalachian Street, Boca Raton, FL 33428, Phone/Fax: 561-487-6103, Website: www.eds-inc.com
**Circle (92) on Reply Card**

### Tool and test equipment

Jensen Tools has released their 300-page Master Sourcebook for 2000. This full-color catalog contains thousands of products from leading manufacturers, including many items that are new to the industry.

The Sourcebook offers an extensive selection of tool kits, test equipment, hand power and specialty tools, wire and cable, soldering equipment, computer and LAN products, diagnostics, workstations, shop supplies, field accessories and more. The company expanded their own line of telecom test equipment to include telephone test sets, tone generators and tracers, and the JTS-45 Test Set.



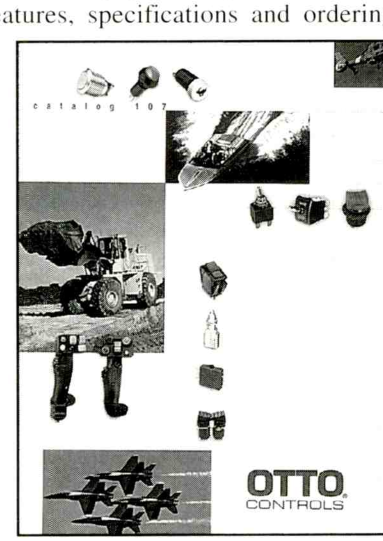

Jensen Tools, 7815 S. 46th Street, Phoenix, AZ 85044, Phone: 800-426-1194, Fax: 800-366-9662, E-mail: jensen@stanleyworks.com, Website: www.jensentools.com
**Circle (93) on Reply Card**

### Switches and custom assemblies catalog

Otto Controls has released an 86-page catalog, 107. This full-line catalog includes features, specifications and ordering information for their entire selection of precision switches and control grips. Products include push button, rocker, toggle, basic, limit, pendant, and special purpose switches in commercial and military versions.

The latest subminiature, illuminated, watertight, and Hall Effect switching technology is highlighted.

Applica-tion- specific assemblies include a variety of control panels and control grips. A military part number cross-reference chart is listed in the back of the catalog.




Otto Control, Phone: 847-428-7171, Website: www.ottoeng.com
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# Introduction

Consumer electronics servicing is a challenging profession. It's occasionally rewarding as well, but as the prices of consumer electronics products continue to drop, even as their complexity increases, it is more and more difficult to find it rewarding.

Keeping up with the changes in technology and circuitry, and maintaining a knowledge level sufficient to allow the technician to service the products would be challenge enough, but today, in addition, there are many other challenges. First of all, just finding and being able to use the service literature can be a struggle.

As most readers know, for example, computer monitor manufacturers make it all but impossible to obtain service literature on their products. And even the best old faithful TV manufacturers have made changes in their service literature systems that have forced service centers to make fundamental changes in the way they store and view literature.

For example, Thomson has now gone completely to electronic service information. If you want to view a schematic of a recent TV from Thomson, or read a description of how the circuits work, or see a parts list, a service center has to pop a CD-ROM into the computer and access the information via the monitor screen or the printer. This is really a good thing, as what used to require a service manual/ parts list several inches thick can now be stored on a single CD-ROM disk. But the service center has to have a computer, and has to learn to use this new system.

Hitachi either has computerized, or will soon, computerize all its service literature and has gone a step further into the computer age. They will not send literature by mail in any form. Service centers will access any of the literature they need from the Hitachi website.

Other manufacturers will surely follow along this same path. Some may have already done so.

With so many changes going on, so many challenges being strewn in the path of service centers, service managers and technicians naturally seek out vendors who make it as easy as possible to get their difficult work done. And as we know, the proliferation of products and models of product increase the number of replacement parts that a service center needs to keep track of and order. For that reason, service centers tend to seek out distributors that can help them find and obtain the critical parts they need to get consumer electronics products back in the hands of their customers as quickly as possible.

## The showcase

Because identifying the faulty part in a malfunctioning consumer electronics product, locating a supplier who can supply a replacement for that part quickly, and installing the part(s) and restoring the product to service quickly and efficiently is so important to consumer electronics service centers, replacement parts distributors are a key element in the service process. Not all replacement parts distributors are alike. Some distributors provide services that make it easy for a service center to assign a part number to a faulty part that may be poorly labeled, or fried so that the part number is not legible, or make it easy to cross a manufacturer's part number to a generic equivalent.

Moreover, some distributors expend a great deal of time and energy evaluating which parts are high-demand parts and making sure that they have plenty of those parts on hand. Or, conversely, they recognize that while a part may not be in high demand, that service centers are going to need a few of those parts, and so make sure they maintain an adequate stocking level of those parts so service centers, and their customers, don't have to wait for a repair because a low-demand part has to come from the manufacturer.

Because replacement parts are such a critical element in the service process, each year this magazine provides a showcase in which we invite distributors to participate. This feature allows distributors to tell readers more about themselves than they would be able to do in an advertisement. We invite readers to peruse these showcase entries so they can get to know these distributors a little better. In addition, we provide the following guidelines to help readers choose a distributor that can best fill their needs.

## Evaluating a distributor

Here's a list of questions you might ask yourself when you're evaluating a distributor.

How many locations do they have?

How often are they able to fill orders from stock?

What payment options do they offer- open order account, credit card, etc.?

How soon after receipt of an order to they ship?

Do they add a shipping surcharge?

Do they have a toll free number?

What ordering options do they offer?

What is their return policy?

Do they offer a warranty?

Is there a minimum order amount?

What shipping options do they offer?

What special services do they offer?

Do they have a research department to help technicians find a specific part?

## Food for thought

Keep some of these questions in mind when you're looking for a supplier of replacement components. You want to find someone you can count on for reliability, convenience, and service. Merely locating someone who stocks the part isn't the only consideration. For example, if you have to wait until you fill a large minimum order amount before you can order, or if you have to wait weeks for the part to arrive, you'll have that defective product sitting around the service center for a long time without earning you any profit, and the customer will not be pleased with the wait.

It might be tempting to order from the first distributor that comes to mind, but if you will take the time to ask a few questions, it might save time, money, and aggravation. The following section will give you a head start in answering some of those questions. ■

# Thomson Consumer Electronics

Thomson Consumer Electronics believes that you should have a choice. We realize that you rely on our genuine replacement parts not only during the required warranty period, but also when you want the highest level of quality and performance available. We also realize that not every estimate you give can be converted to a repair using original parts. That's our difference. We give you a choice!

### Original Parts

RCA and GE genuine replacement parts provide today's service professional with the reliability they need when completing in-warranty repairs. And they are delivered to you by parts distributors who provide an outstanding level of service. In fact, our most recent survey of the service industry continues to show that three out of four servicers believe that no other manufacturer provided a consistently better parts fulfillment system than the Thomson Consumer Electronics' parts distributors.

Thomson Premier Distributors can fill your warranty parts orders either off their shelves on all in-stock products, or by placing a Direct Drop Shipment (DDS) order via computer directly into the TCE national parts depot. Either way, you receive the part you need to complete the repair quickly and you get the highest possible fill rate for warranty parts to service RCA, GE, and ProScan products. This computer link also allows the Premier Distributor access to all the information needed to provide you with the high level of service you require in today's fast paced business.

### SK Series Universal Parts

You know that lower estimates equal more repairs and more business for you. To help you turn more of those COD estimates into repairs, Thomson continues to broaden its line of SK Series Universal Products. These quality parts let you reduce the repair estimate by lowering your replacement parts cost, and that's good news for you!

SK Series Universal Products cover a wide range of high wear, high usage parts. Whether you need video heads, flyback transformers, video replacement parts, belts, tires, pinch rollers, laser pickups, RF modulators, exact semiconductors, servicer aids, repair kits, capacitors, resistors, and more, you can look to SK Series first.

### TCE Literature

Thomson also provides a number of publications which makes finding the right part for the repair even easier. Our latest SK Series Product Guide (Catalog #301) is a quick reference tool to the SK Series Universal Product line. Photographs, text, and graphic illustrations all help guide you to the right stock number very quickly and easily.

In addition to TCE service data, the "Television Components Quick Reference Guide" contains key part numbers for recent RCA, GE, and ProScan chassis. It's ideal for the technician on the road. It folds to fit in your pocket. The Quick Reference Guide also contains a section dedicated to the EPROM's associated with chassis CTC168 through CTC187.

And there is of course, our well-known and widely accepted OEM Remote Control book. This book is printed once a year and no one that repairs TCE products should be without one!

These publications are available from your Authorized Thomson Parts Distributor. For the SK Series Product Guide order publication 1J1226, for the Quick Reference Guide order publication 1J9548 and for the Remote Control Book order 1F5790.

### Accessories and Components Business

The Thomson Consumer Electronics, Accessories and Components Business provides service from a 358,000 square foot facility located in Deptford, New Jersey. All business functions — customer service, sales and marketing, quality assurance, product analysis, administrative departments and warehousing — operate under one roof. Some parts are stocked in satellite warehouse facilities in El Paso, TX and Indianapolis, IN.

A full line of RCA brand Consumer Electronics Accessories is marketed from this facility as well. The business is managed by Jack Nick, Vice President. Thomson Consumer Electronics corporate headquarters is in Indianapolis.

### One Call Is All You Need To Make

Whether you need original RCA and GE parts or SK Series products, your Thomson distributor is your one stop source. A single call to a Thomson Distributor gives you the choice you deserve, making your business more profitable. To locate a nearby Thomson Authorized Distributor simply call (800) 336-1900 today. ■

# Andrews Electronics

**25158 Avenue Stanford**
**Santa Clarita, CA 91355**
**Phone: 800-289-0300 Fax: 800-289-0301**
**Website: www.andrewselectronics.com**



Andrews Electronics is housed in 50,000 square feet of warehousing and office space. Miles of shelving are arranged for immediate identification and easy accessibility for over 250,000 different parts that we carry.

Maintaining an inventory of this size has been the cornerstone of our success as the O.E.M. parts distribution industry leader. It provides us with an average first pass fill rate of above 90% and makes us the largest supplier in America for the manufacturers we represent. Our fill rate is calculated on not only everything that is ordered but also on every call or fax we receive for availability, even if it isn't ordered! Our dealer order desk has 32 available sales representatives to handle all of your ordering needs.

We've built our reputation on a very simple philosophy. . . service. Not very fancy, but very effective. Our constant growth attests to it. You see, all of our policies that have been developed over the years have been based on that one simple thought: "How may be better serve the industry?" How about:

- 14 major brands to save you time, frustration, and money with "one-stop shopping."
- Orders placed before 2:30 PST are routinely shipped the same day.
- A freight program that offers free and discounted shipping.
- No minimum orders or handling charges.
- Automatic backorder reports with ETA's mailed bi-weekly.
- A fast, highly-efficient research department, second to none.
- A program that converts make/model descriptions to part numbers instantly for the majority of research requests.
- 24-hour toll-free phone and fax order lines.
- Over 100 full-time employees waiting to serve your needs.

Our already outstanding freight program has been drastically improved! The minimum qualifying amount has been cut in half and the 2 day air discount has been almost doubled! With this type of shipping program, we're a lot closer than you might think.

In case you've heard this elsewhere before, now's the time to let us prove it to you. By investing a mere two minutes of your time, you can discover what thousands of others have: that there is a difference. When you place your next order with your local supplier, check the availability of all the items. Then call or fax Andrews and check out our stock levels. We believe you'll be pleasantly surprised! Wouldn't getting those extra units repaired a week or two sooner be good for your reputation? Sure it would! And we can help! After all is said and done, it is performance that counts. We know that your ability to perform your job depends on how well we perform ours. Our regular office hours are from 8:15 to 4:45 PST and we're closed for lunch between 12:00 and 12:30. When you think of electronic parts . . . think of Andrews. ■

# B&D Enterprises

**P.O. Box 460**
**Main & Liberty St.**
**Russell, PA 16345**
**Phone: 800-458-6053**
**Fax: 814-757-5400**
**E-mail: sales@bdent.com**
**Website: www.bdent.com**


B&D Enterprises is your *Semiconductor* specialist. Filling your semiconductor requirement is our #1 priority. Our objective is to meet the consumer and industrial repair market's demand for a price competitive, well-stocked, highly knowledgeable, factory authorized distributor.

## JAPANESE SEMICONDUCTORS

B&D Enterprises stocks more than 15,000 line items. Specializing in Japanese semiconductors, we can help you solve your component problems.

Since 1976, B&D Enterprises and their parent company have been entrusted by the manufacturers to be the authorized distributor in the United States. Companies such as Sanyo Semiconductor, Sanken Electric, Shindengen America, and NEC Electronics trust us to handle the ever-growing need for a dependable, customer service oriented stocking distributor. At B&D, you'll find 23+ years of accumulated product knowledge and factory direct supported sales.

We also carry an extensive inventory of hard-to-find and discontinued products, as well as many components made by non-Japanese manufcaturers.

## PRODUCT KNOWLEDGE

Our sales staff is technically trained. To service the OEM customers, we have to be. We have the largest library of semiconductor manuals in the market available to support our sales. Hundreds of part cross references are in our database. We back what we say. When we offer a cross, we know it's right and can send you the specifications to prove it. Feel free to talk to our Engineering/Technical Support office at 814-757-8300.

## PRODUCT RELIABILITY

As a factory authorized distributor, we only sell original quality manufactured parts. NO "rebrands," NO "off-brand" imitation manufactures, just original components. We feel that our customers deserve a part that works, not one that's close.

## CONVENIENCE

To better serve our customers we offer them the WEBSITE — at www.bdent.com you will find our ENTIRE INVENTORY for you to view. 24 hrs a day, 7 days a week, you can check prices, request quotes, and place orders on a secure server. We update our site DAILY with new parts and prices.

Go factory direct with B&D and get the price you need with the factory authorized service you deserve!

Call today for our FREE 2000 CATALOG and see what a difference we can make! Selling a lot of things doesn't make us better, just diversified. At B&D, we do one thing, and we do it right! ■

# Replacement parts showcase

## Herman Panson

**7350 Herman Way**
**Miami, FL 33122**

**45 U.S. Highway 46 East**
**Pine Brook, NJ 07058**

**Phone: 800-938-4376**
**Fax: 800-938-4377**

Herman Panson is a diverse and multi-faceted full-line distributor of everything in electronics, committed to offering only the best in original replacement parts and everything in service accessories including tools, test equipment, cable, connectors, semiconductors, chemicals, and most importantly, customer service to their customers. In business for over 40 years, Herman Panson has clearly established itself as one of the leaders in the industry by providing only quality products and outstanding customer service to all facets of the electronics industry.

The heartbeat of the company lies in the OEM parts department. While serving the industry for over 3 decades, Herman has most of the major OEM parts lines enabling them to provide more efficient and cost effective service to you, their valued customer. The company prides itself on being a SINGLE source to the service industry. Herman Electronics is one of the largest original replacement parts and accessory distributors in the country and is factory authorized for SONY, PANASONIC, THOMSON-*Premier* (RCA-GE-PROSCAN), SAMSUNG, QUASAR, TECHNICS, TOSHIBA, HITACHI, (*Elite Distributor*), DAEWOO, KENWOOD, DENON, PHILIPS, MAGNAVOX, SANYO, FISHER AND ZENITH. Stocking one of the largest and most comprehensive inventories in the country enables the company to fill over 80% of their orders from inventory and guarantees SAME DAY shipment of all in-stock orders placed before 5:30 P.M. (EST).

In addition, Herman Panson is the source for everything in service accessories, distributing only name brand products. If you need it, Herman Panson has it. Tools, test equipment, soldering equipment, chemicals, power products, technician aids, cable connectors, and accessories from all of the industry leading manufacturers including Fluke, Sencore, Hakko, Chemtronics, Belden, Xcelite, APC, B&K, Weller, Tripplite, and many more.

Herman Panson has launched their new internet based, live interactive website. Get on line with THE PROS, the Herman Panson Parts Remote On-Line Service. This new site provides their customers with direct access to OEM parts ordering, pricing and availability, ETA information, order status, package tracking and more. This new system makes ordering and inquiring faster and more efficient than ever before. Also while on line, visit the Herman Panson CYBERWAREHOUSE! Now you can shop on-line at their electronics superstore. This completely interactive site contains over 5000 items including photos & manufacturer's specifications on everything in service accessories. Simply point, click, and your order is on the way. Also take advantage of their constantly changing specials for great value and savings. All this and more available NOW at the Herman Web Site www.HermanPanson.com.

If you haven't given Herman Electronics a try, please do so today. Call to request a copy of their new catalog or simply visit them on the world-wide-web at *hermanpanson.com*. Herman Panson... Leading the Way. ■

# Electronic Design Specialists

### 4647 Appalachian Street
### Boca Raton, FL 33438
### Phone: 561-487-6103 • Website: www.eds-inc.com

Electronic Design Specialists makes test equipment designed to help servicing electronic technicians troubleshoot problems as quickly and accurately as possible. All test equipment is designed by David T. Miga, CET, who is both an electronic engineer and a certified electronic technician.

The EDS Corporation was started in 1986 when Dave designed a digital capacitor meter and a semiconductor analyzer to increase his own productivity as a contract technician. When other technicians saw what the EDS-52 capacitor meter and the EDS-59 semiconductor analyzer could do, Dave found himself being asked to build more of these prototypes for them. The production version of the semiconductor analyzer, the SemiAnalyzer 59C, was very successful and was sold from 1987 until 1997. Other unique test equipment followed, such as the Bus Line Tracer, the MicroAnalyzer, the LeakSeeker, and the very popular CapAnalyzer. Although designed for independent service technicians, regular users are the U.S. military, most of the Fortune 500 companies, NASA, the TV networks and cable companies, Panasonic, Pioneer and many trade schools and colleges.

Dave designs his test equipment with an entirely different perspective than most test equipment companies. All ideas start with interviewing thousands of independent service technicians for their opinion and special needs. This approach is different from conventional test equipment manufacturers, where equipment is designed by engineers that may have never picked up a soldering iron, who wouldn't be able to repair their own television, even with their own test instruments. Their idea for test equipment is to bombard the technician with numbers, to be expensive and to be difficult to use. This is overkill for a servicing technician; check out the "used test equipment" section in the classifieds of this magazine for these products.

For this reason, all EDS equipment is designed to give the technician the tools to tell whether a component is good, poor, or bad, in circuit, as accurately as possible. A technician doesn't need to know what a capacitor's dissipation factor or dielectric constant is; just is it bad, can I move on? EDS test equipment is designed by technicians for technicians, is guaranteed accurate for in-circuit tests, and is designed for easy use. Determining the quality of a component in question is done by the test instrument, not the technician.

To design a test instrument to decide whether a component is good or bad, EDS analyzes actual defective components sent in by technicians. Calibrating the test equipment is done by comparing new, old but still working, and known defective components, then programming the test equipment to make the decision, with Dave's 30-year experience as helpful input. Every CapAnalyzer 88A is still tested with the same actual good, poor, and bad electrolytics and tantalums used to design the original prototype, before releasing it to the customer.

EDS was the first on the World Wide Web with animated demonstrations of test equipment products, and has one of the best technical assistance programs on the Internet. You can even download replacement owner's manuals and review tech tips, and get self-maintenance help for each product.

As the electronic service repair industry moves into the twenty-first century, more and more technicians will discover that to be productive, less time must be spent looking at schematics of increasingly complicated circuits. Simply checking components in the circuit with the problem, with the right test instruments, is how profitable repairs will be done by the surviving technicians of the new millennium.

EDS products are available from your distributor. For international sales contact EDS directly. Check out www.eds-inc.com for a current list of distributors. All products come with a 60-day satisfaction guarantee or money-back policy.

# Products

## High velocity dusters

Techspray introduces Vortex and Vortex 360 high velocity dusters, for increased power and performance. Vortex is formulated with HFC-134a, an exceptionally pure, moisture free, inert gas. Vortex 360, an invertible high velocity duster, can be sprayed in any direction without threat of dispensing liquid on valuable equipment. Both are residue free, zero ozone depleting and non-corrosive in addition to being safe for use on most plastics.


The dusters are designed to effectively clean and remove microscopic contaminants and dust particles from all types of electronics equipment. They are useful for the removal of dust, lint and other contaminants from computers, printers and optical cleaning equipment.

Techspray, P.O. Box 949, Amarillo, TX 79105-0949,
Phone: 800-858-4043, Fax: 806-372-8750

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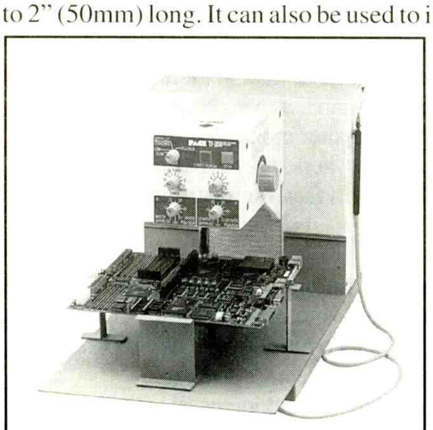
## Hot air soldering and desoldering

The TF 350 from Pace is a convective surface mount soldering/desoldering system that does not require nozzles. The unit is capable of removing any type of surface mount component, including area array devices, and surface mount connectors up to 2" (50mm) long. It can also be used to install most SMT packages. The system features multiple modes of operation, adjustable temperature and airflow, as well as a timer for repeatable operations. Using the integral hot gas jet, the unit can be configured to trace the land pattern of QFPs, SOICs, and TSOPs or to make concentric passes over area array packages. The stations includes a fully adjustable work platform capable of holding most PCBs and comes with a board support and a vacuum wand for placing or lifting components from the PCB. This system is self-contained and requires no external vacuum or air supplies.



PACE, 9893 Brewers Court, Laurel, MD 20723-1990,
Phone: 301-490-9860, Fax: 301-604-8782, Website: www.paceworld.com

**Circle (101) on Reply Card**

## Data logging multimeters

Extech's new Multilog series of Datalogging MultiMeters, Models ML710 and ML 720, provide 10 selectable datalogging sample rates from 0.05 second (50ms) to 480 seconds (8 minutes) per sample for high speed data collection or long time studies. Model ML 720 features a 43,000 data point memory and Model ML710 features a 5400 data point memory. Stored data can be viewed directly on the LCD with quick min/max and trend displays. The optically isolated RS-232 PC interface with Windows 95/98 compatible software (included) allow the user to collect, display, plot, save, or export data or graphs. Functions include True RMS measurements for voltage and current, resistance, selectable F/C temperature, frequency, capacitance, diode, and continuity. The basic voltage accuracy is 0.08%. Measurements are displayed on a backlit 5000 count LCD with high resolution: 0.01mV, 0.1uA, 0.01, 0.001Hx). Features also include a wide voltage bandwidth of 40Hz to 20kHz, smart Auto Power Off which is disabled if a signal is present at the test leads, high and low resistance autolead zero, and water resistant housing. UL listed. Meets IEC 1010 CAT II - 600V, CAT II -1000V. Complete CAT III test leads, temperature probe, Windows® 95/98 compatible Data Acquisition software, RS-232 cable, protective holster, and 9V battery.

Extech Instruments, 285 Bear Hill Road, Waltham, MA 02451-1064,
Phone: 781-890-7440, Fax: 781-890-7894,
E-mail: extech@extech.com, Website: www.extech.com

**Circle (102) on Reply Card**

# The D7 chassis

by Bob Rose

Philips introduced the D7 chassis in the late summer-early fall of 1998, putting it into high-end televisions with 27", 32", and 36" picture tubes. It features a very large-scale integrated circuit (VLSI) that performs video IF processing, AFT/AGC control, horizontal and vertical synchronization, chroma-luma processing, and video switching in those versions that don't come equipped with a PIP. In addition to its normal functions, the system microcomputer generates on screen data, closed caption decoding, and processes automatic volume level (AVL) information that is sent to the stereo decoder over the $I^2C$ (I-Squared-C) bus. If you get the feeling that the D7 is both new and complicated, you have gotten the point.

## The power supply

The system that I want to deal with in this article is the power supply — that circuit that gives us servicers more trouble than any other. Following contemporary trends in technology, the D7 utilizes a switching type of power supply meaning among other things that the chassis has a "hot" ground and "cold" ground. The hot ground includes the components on the primary side of the switching transformer while the cold ground includes those that are on the secondary side, which in basically the rest of the chassis. Because of the dual ground system, you must use an isolation transformer when you service the chassis.

Rose is an independent consumer electronics business owner and technician.

You really need two pieces of literature to service the D7's power supply. The first is a block diagram (Figure 1), which breaks the circuit down into easily conceptualized units, and the second is a full schematic, not included. You can find both in the factory service manual that you may secure by ordering manual 7550 from Philips Consumer Electronics. Microfiche 98-7550 might come with it. However,the manual is about all you will ever need since it contains block diagrams, schematics, "how it works" sections, and a complete parts list. Here is the address in case you need it:

Philips Consumer Electronics Co.
Technical Publications Department
Post Office Box 555
401 East Old Andrew Johnson Hwy.
Jefferson City, TN 37760

## Expected voltages

Let's do things a bit differently by looking at the voltages a working power supply produces before we look at the actual power supply (a partial schematic of the primary is shown in Figure 2). The following readings are taken with a dummy load of 165Ω connected from "Vbat" (we're going to have to learn a few new terms) to ground. Incidentally, "Vbat" is the 130V source. Do I need say that the horizontal output transistor should be removed from the circuit? I thought about saying "either removed or disconnected," but it's really best to remove it. With the output transistor out of the way, simply solder the dummy load between the collector (+130V source) and emitter (cold ground) connections.

The numbers in the "at component" column denote filter capacitors. For example, 2916+ means the reading is taken at the positive terminal of the filter capacitor on the 130V line. "Pin 2 of

| Voltage Source | Value | Tolerance | Tolerance At Component |
|---|---|---|---|
| Vbat | 130V | 1V | 2917+ |
| Vsound | 13.5V | 1V | 2925+ |
| Vstby | 5.1V | 0.1V | 2938 |
| V+5V | 5V | 0.2V | 2937+ |
| V+8V | 8.3V | 0.2V | 2931+ |
| 33V | 33V | 2V | 6955 cathode |
| 200V | 206V | +5V to –35V | Pin 2 of M60 |

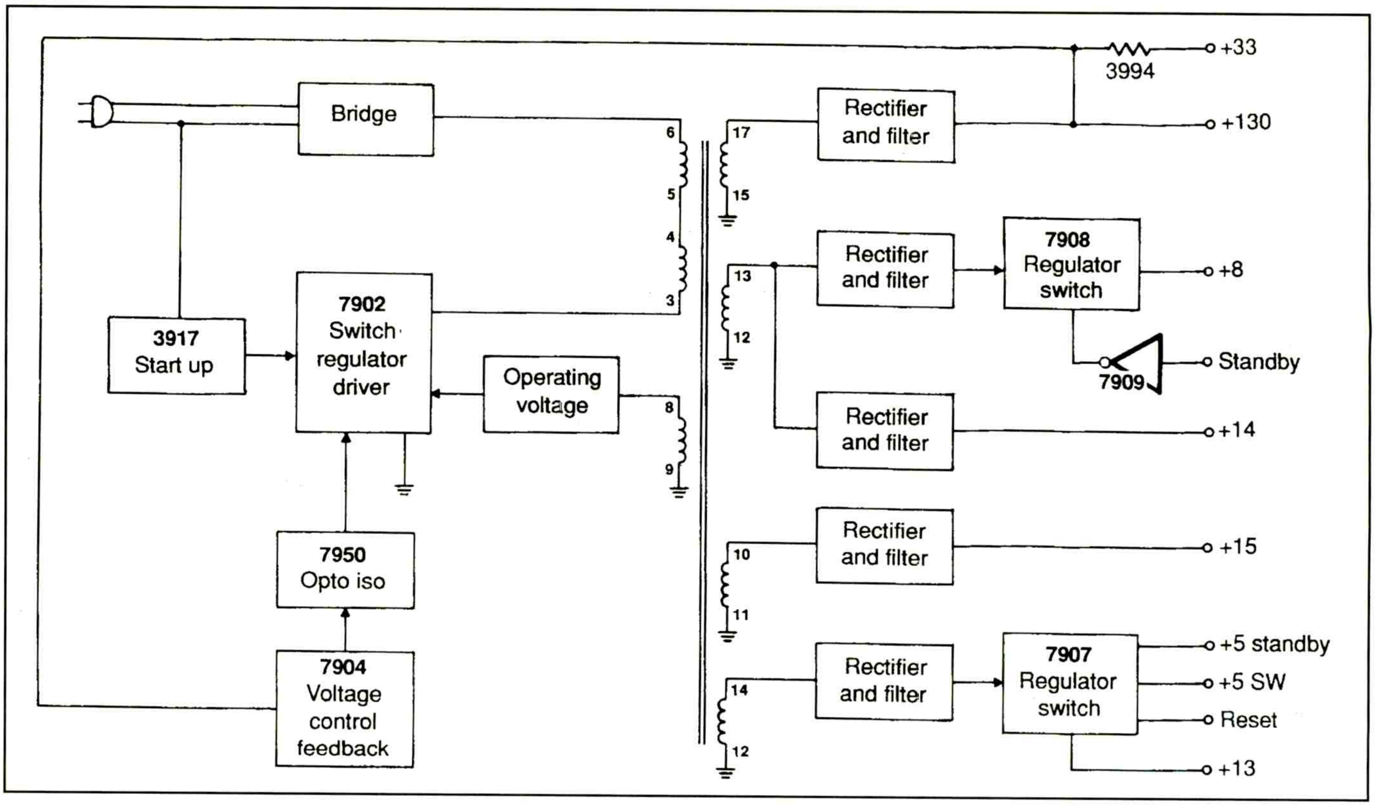



**Figure 1.** This block diagram of the D7 chassis breaks down the circuit down into easily conceptualized units.

M60" means the reading is taken at pin 2 of connector M60. You see, we're having to learn not only new terminology but also a new component designation system.

The literature says that power consumption at "the worst control setting" is 1.6A which translates into about 192W. Quite an efficient power supply, isn't it?

### How it works

AC is input through what the engineers call a "mains filter" (Figure 3) which is a group of components on a separate circuit board consisting of an ac cord, a fuse, capacitors, and chokes. It is designed to keep ac "hash" out of the supply, to keep the supply from radiating "hash," and to protect the power supply from damage caused by fluctuating ac voltages.

The power supply is configured around a single integrated circuit, a STR-F6626 (IC 7902). When ac is applied, the bridge rectifiers develop about 160Vdc, which is applied to 7902 through transformer 5912. Start up voltage is taken off the hot leg of the ac input and applied to pin four of 7902 via resistor 3917. These two voltages cause the switch inside the IC to turn on causing current to flow through the primary of the transformer.

When the current flow reaches a certain point, the switch turns off. If the power supply is working correctly, the switch turns back on at a certain point, and the cycle of "on-off," which is the switching action, repeats itself thousands of times a second. The energy that is stored in the primary during each "on time" is transferred to the secondary after the switch turns off to provide the current necessary to operate the television.

The current delivered to IC 7902 via resistor 3917 (not shown) is sufficient to kick start the switch but insufficient to provide operating voltage. IC 7902 has an "undervoltage lockout circuit" at pin four that prevents the IC from starting until the applied voltage reaches +16V. Capacitor 2912 (not shown) charges through resistor 3917 until the charge reaches +16V and the IC starts.

Once the switching begins, the waveform developed at pin eight of transformer 5912 is rectified and used to keep the charge on capacitor 2912 above the undervoltage lockout value. Those of you who are familiar with Philips products immediately recognize this as a vintage Philips circuit.

The +130V line is the reference for the power supply. It is sampled by the voltage control feedback IC 7904 (a SE130N) that drives LED portion of opto-isolator 7950. The transistor portion of 7950 is connected to pin one of 7902 and used to control the on time of the switching transistor. The arrangement permits tight control of the output of the power supply.

The diodes and capacitors in the secondary windings of transformer 5912 develop the voltages necessary to operate the TV. A couple of these need additional comments. The D7 has just one power supply, meaning there is no separate standby supply. IC7907, a TDA8137, develops the standby voltages by outputting B+ and reset for the microcomputer, B+ for the remote receiver, and a switched +5V when the scan-derived +13V becomes available. The second voltage that needs an explanation is developed by 7908, a LM317T used to develop the switched +8V. The TV turns on when the microprocessor sends out a high on the standby line turning on transistor 7909, which turns on IC7908 making the +8V available to the TV signal processor that is responsible for developing horizontal drive.

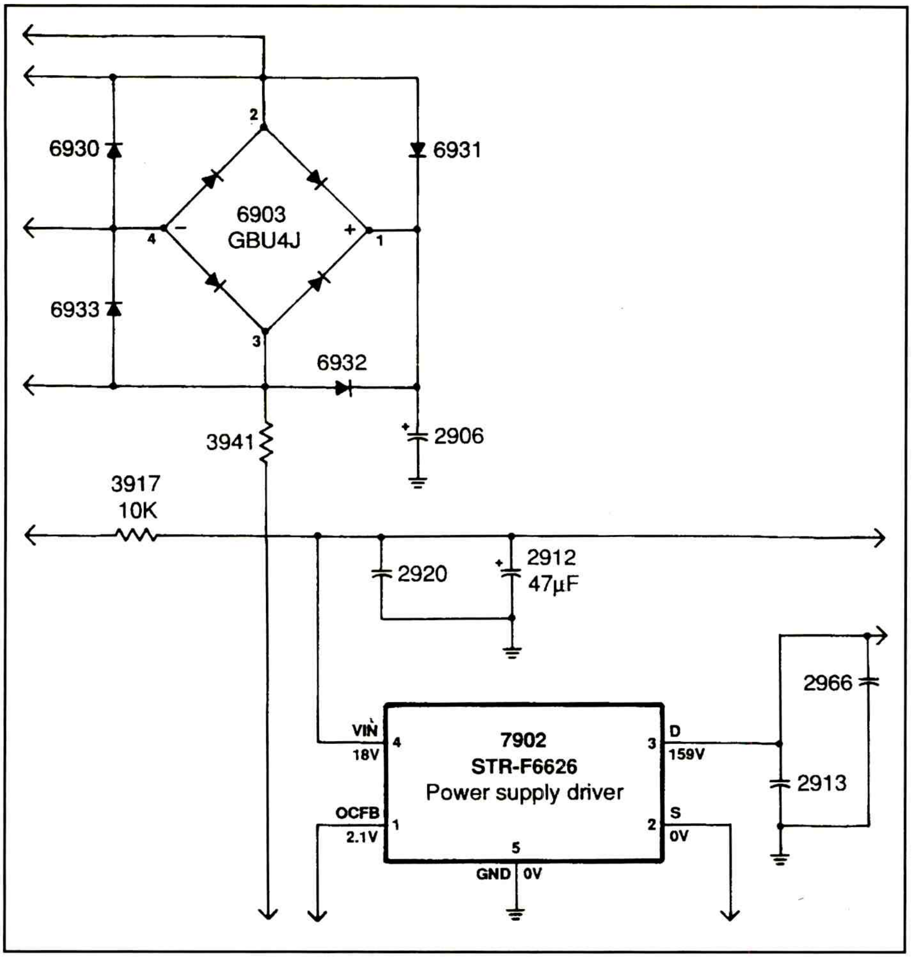



**Figure 2.** A partial schematic of the primary side of the D7 power supply.

Our Philips field engineer gave us at a recent service meeting what he called some "real world" voltages obtained by taking actual measurements from six working D7 chassis. I believe you will find them to be a handy reference. The voltages in brackets are standby voltages.

| | | |
|---|---|---|
| **Component 7902** | | |
| pin 1 | [1.7] | 2.1 |
| pin 3 | [159.0] | 159.0 |
| pin 4 | [14.5] | 18.0 |
| **Component 7950** | | |
| pin 4 | [.7] | 3.2 |
| pin 5 | [14.5] | 18.0 |
| pin 2 | [9.7] | 12.0 |
| pin 1 | [10.7] | 13.0 |
| **Component 7909** | | |
| collector | [0] | 7.25 |
| base | [.7] | .1 |

### Troubleshooting the power supply

Don't assume that the power supply is inoperative until you have checked at least two of the secondary voltages. If you check just one and find it missing, you might have found just a missing voltage. One of the pico fuses (1905 or 1906) may have opened, for example. However, chances are excellent the power supply isn't working when you find more than one voltage missing.

After you have found more than one secondary voltage missing, check for the presence of raw B+. Do you, in other words, have about +155V at pin three of 7902? If you don't, common sense should tell you what to check next. Second, check the startup voltage at pin four. If it is missing, check the components associated with it, especially resistor 3917.

If these voltages are present but the voltage at pin four ramps up and down, suspect a problem in the run B+ supply. Lots of techs pick up a DMM to make such a check, but a scope is a better instrument to use because its gives you a visual clue that the voltage is rising and

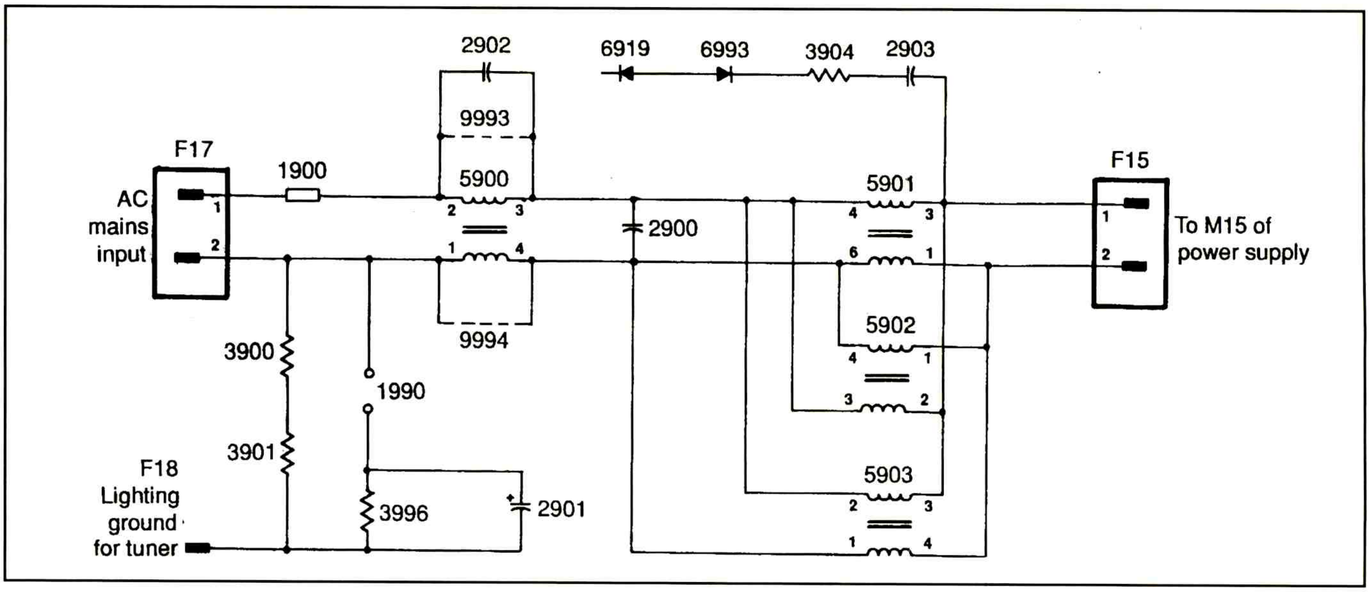



**Figure 3.** In this set, ac is input through what the engineers call a "mains filter," which is a group of components on a separate circuit board consisting of an ac cord, a fuse, capacitors, and chokes.

falling. Be smart; use a scope. The ramping voltage is a good indication that the power supply is starting but not running. Begin by checking the components between pin four of the IC and the primary winding of transformer 5912. Diode 6908 or resistor 3959, for example, might have opened.

I am not sure that the literature tells you this, but an excessive load on the +130V line might also cause the voltage at pin four to fluctuate. In other words, a short on the line may permit the IC to start, but the overcurrent protection circuit keeps it from running, hence the fluctuating voltage at pin four. With the TV unplugged, use your ohmmeter and make a quick resistance check. A low resistance reading between the line and cold ground indicates a shorted component like a defective horizontal output transistor. More about this in a few paragraphs.

If startup and B+ are present and the supply still isn't working, check 7902 itself by taking a few resistance measurements. The switch inside 7902 is a FET and can be checked like any FET. For instance, the resistance between pins two and three (source and drain) should be very high while the resistance between pin three and hot ground should be on the order of 100k. If this resistance is low, like on the order of 500Ω, the bridge rectifiers, the main filter capacitor, or the IC itself is shorted.

It is also a good idea to take a couple of minutes and check each resistor and diode in the primary circuit. I make this comment based on experience because I have fought such problems for a long time only to discover an open resistor or leaky diode had kept the power supply from operating.

### When you replace a defective switching IC

The engineers at Philips suggest that you ought to replace a few other parts when you replace a shorted IC7902. If you don't, you run the very real risk of damaging the new part (s).

First, replace coil 5906 and resistor 3924 along with the fuse and IC7902. Components 5906 and 3924 are located in the source of the FET and will probably have been damaged when 7902 shorted. Replace them with Philips exact replacement parts only. These are precision components and crucial to the proper operation of the power supply. You may think generic parts will get you by, and they might for a while. But do it right, and get those parts from Philips.

Second, check the feedback circuit. A defect here will cause the output of the power supply to be unstable and could lead to catastrophic failure of the new parts. Fortunately, it's an easy check to make. Begin by unsoldering pins one and two of 7904. Using an ohmmeter check the resistance between pin one and cold ground. Use pin three as a reference because it is tied to cold ground. You should have a reading of about 75k. Then check the resistance between pin two and ground, which should be on the order of infinity.

Second, check IC 7950 by attaching a variable dc power supply between the 14V line and cold ground. Set its output to 0V. Then connect an ohmmeter between pins four and five of opto-coupler 7950 by connecting the negative lead to pin four and the positive lead to pin five. Then ground pin one of 7904. When you ground this pin, you eliminate the need for the +130V source to be present for the check. You are now ready for the test. The resistance reading on the meter should be very high at this point. Slowly increase the dc supply while you monitor the meter. The resistance should begin to drop and reach about 100Ω as the dc supply approaches an output of 5V. Don't increase the dc supply's output to more than the +5V to prevent damage to the IC. If you get the expected results, you may be reasonably sure the feedback circuit is working.

Third, check the resistance-to-cold-ground of all secondary voltages. Make the checks at the cathodes of diodes 6913, 6960, 6914, 6918, and 6917. Expect to find a reading at each point in excess of 20k.

Fourth, make two resistance checks at IC 7907. Pin seven to ground should be

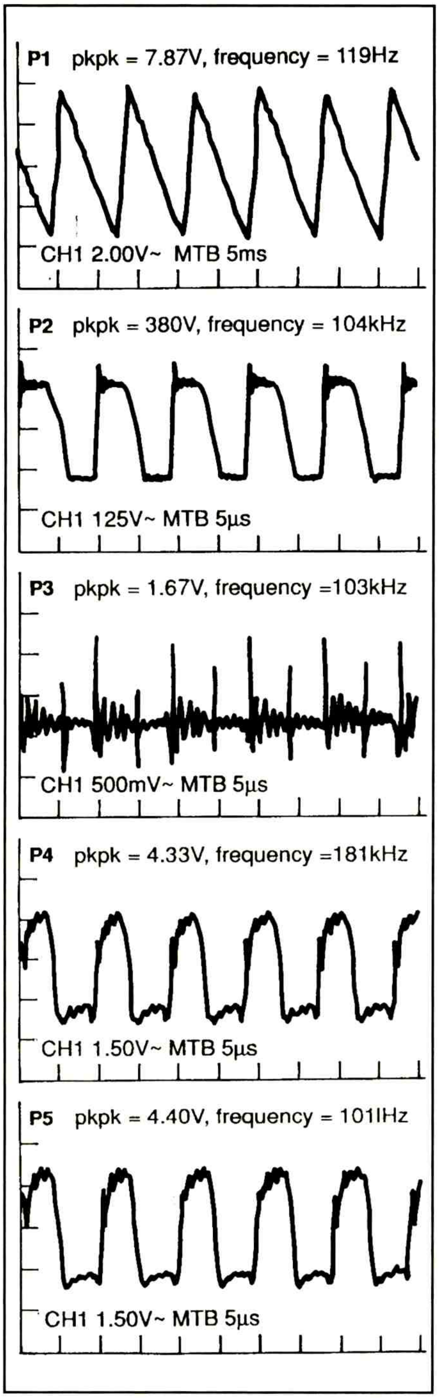



**Figure 4.** Critical waveforms observed in the circuits in this set.

on the order of 4k, and pin six to ground should be about 1100Ω.

Fifth, move your meter probes to IC 7908 and check the reading between pin two and ground where you ought to find a resistance of about 1500Ω.

If you find a short, repair it. When you are satisfied there are no shorts or excessive loads, you are ready to test your work. Note that I said, "ready to test your work," not "ready to apply ac."

### How to test the repair

Once you have replaced the damaged components, confirmed the operation of the regulator loop, and ruled out excessive loads, you are ready to test the repaired power supply. Let me suggest you follow these steps.

(1) Ground pin one of 7908 to prevent the +8V from coming up. The microprocessor remembers the last state it was in before power was lost. If the power supply failed while the TV was on, the microprocessor "remembers" that TV was on and attempts to turn it on when ac is applied. Grounding pin one of 7908 inhibits horizontal deflection while permitting the power supply to come on line at the pace you desire. You see, you are guarding against possible additional damage to the set.

(2) Plug the power cord into an isolation transformer-variac that has been set to 0V and begin to bring the ac up slowly to about 50V while you monitor pin three of 7902 with an ac-coupled scope. Look for a waveform similar to the one labeled "P 2" in Figure 4 with a peak-to-peak value of about 220V.

(3) Measure the output voltages using the "expected voltages chart" I gave you earlier. If the voltages are normal, increase the ac to the full 120V. Now you should see a $300V_{PP}$ waveform at pin 3 of 7902. If everything checks okay, remove ac and the jumper you installed, and see what happens when you fire the TV up.

### Conclusion

I know I have left you with the impression that repairing a defective D7 power supply is a long, tedious process. However, I believe you will find it far less time consuming than you think once you get elbow deep into a repair and especially after you have done a couple. Most of us are accustomed to short cuts to make a repair as quickly as possible so we can move on to the next job. Let me caution you to delete the short-cut mentality from your "directory" when you put a D7 on your bench. Taking the time to make the checks I have suggested just might save time and money, both of which belong to you. ■

## Books

***Manufacturer to Manufacturer Part Number Cross Reference* by the Engineering Staff of Sams Technical Publishing, 320 pages**

Desperate to get that replacement part? Wondering if that two-week wait for one part is worth it? Have a workshop full of parts you aren't sure are the right replacements? With the Manufacturer to Manufacturer Part Number Cross Reference you will have the source for finding all the possible alternative replacement parts — a tool your workshop has always needed! The engineers at Sams, using years of hands-on experience, have put together this handy cross reference guide that should be a part of every technician's library. Created from the Sams database that was developed through the production of PHOTOFACT® service documentation, this guide gives you the knowledge to use electrically compatible parts already in stock. A reference tool this important saves time and money making it a wise investment for anyone servicing consumer electronics devices.

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# Closed caption decoder

by Steven J. Babbert

The current trend in television design is to contain the closed captioning decoder within the system control microprocessor or SYSCON. This is the logical place for it since it consists mostly of digital circuits. There are, however, many TVs still in service that utilize a separate caption decoder IC. In many cases, these are used in conjunction with yet another IC that acts as an interface between the decoder and the main signal processor or "TV-chip." The Magnavox chassis #25Y100 is just such a chassis and we will take a look at how it handles decoding and display of closed caption information. First let's refresh on the basics.

### The basic system

Most technicians are familiar with the basic method used to transmit the Program Related Data Signal (PRDS), more commonly referred to as "closed captioning." The information is sent on line 21 in the unused "overscan" portion of the raster during the vertical blanking interval. Most technicians also understand that one line of video information is required for each line of reproduced video in the raster. Closed captioning typically uses up to about 20 percent of the raster or roughly 100 lines. The obvious question is, how can such a large portion of the raster be represented by a single line?

The displayed captioning has three characteristics that simplify the problem considerably. First, the captioning is always on a solid black background. In other words, there is essentially no information required to create the caption background. The background is generated by the caption IC. Each character is automatically enclosed in a black box.

Second, captions are composed of a finite number of alphanumeric characters along with a few miscellaneous symbols and punctuation marks. These characters are stored in onboard memory in the caption decoder IC. All that needs to be sent from the transmitter is the address information required to retrieve and display the individual characters. There is no need for the type of complex information that would be required for a pixel-by-pixel reconstruction of a given character using the conventional NTSC method. The digitally encoded address information will easily fit on a single line.

Third, while picture information is constantly changing, captions remain unchanged for a few seconds at a time until they are updated. The line carrying the caption information is updated and read many times during this period. The overscan portion of the raster where the information is contained repeats approximately 60 times per second. The caption decoder combines information from each subsequent "slice" and assembles each new caption while the current one is being displayed.

In the vertical blanking interval, all of line 21 of the odd fields and half of line 21 of the even fields are used for PRDS. Even field lines hold a framing code used by the decoder for positioning of the caption. Odd field lines carry seven cycles of 0.503MHz clock run-in for synchronization followed by a start bit and two 7 bit + parity ASCII characters.

### The method of transmitting closed captioning

The fact that the actual characters are not transmitted explains why they are not subject to the same kinds of distortion as the video. Under poor signal conditions, the wrong characters may be displayed but they will not usually be distorted or weak like the rest of the picture. This is because the address information is not being read correctly. If the signal is so poor that the caption IC detects a problem, white boxes will be displayed. If the signal becomes too weak, the caption decoder will shut down and no captions will be displayed.

A detailed explanation of how the caption decoder translates digital information into individual characters will not be given here. Instead, we will focus on the signals entering and exiting the IC; the signals that you will be looking at during troubleshooting. This "black box" method of observing input and output signals of a given IC will generally tell you what you need to know.

### A Magnavox system

Figure 1a shows the closed caption decoder, IC355. The block diagram of IC355 is also shown in Figure lb. The CVBS (Composite Video Baseband Signal) is applied to the base of video buffer Q381 after passing through a chroma trap. The chroma trap eliminates the 3.58MHz chrominance signal which could interfere with the operation of the caption decoder. The common collector buffer stage helps to prevent the caption decoder from loading the video circuits needed for reproduction of the video signal.

The CVBS signal originates at the video detector output pin 52 of TV chip IC270 (Figure 3). The signal is then passed through an additional video buffer stage, Q210, ahead of the caption take-off point. Q210 is primarily for isolating the video detector from the luminance section.

A data slicer block in IC355 isolates the appropriate line from the video signal so that the data can be read. Essentially, it is a switch that is gated on at the beginning of the data stream. At the end of the stream it is turned off, blocking the regular video signal. The slicer output contains caption-related information only.

A sample of the flyback pulse enters the IC at pin 8. The pulse is compared to the sync of the composite signal to facilitate correct timing, ensuring that the text will be properly positioned on the raster. This is basically the same system used to keep the picture phase and frequency locked.

IC355 is enabled when pin 1 is pulled to logic high (5V) by the SYSCON. Language selection is made by changing the logic level at pin 18 and is controlled by the SYSCON. Reset takes place when C333 charges to 5V via R335 during power-

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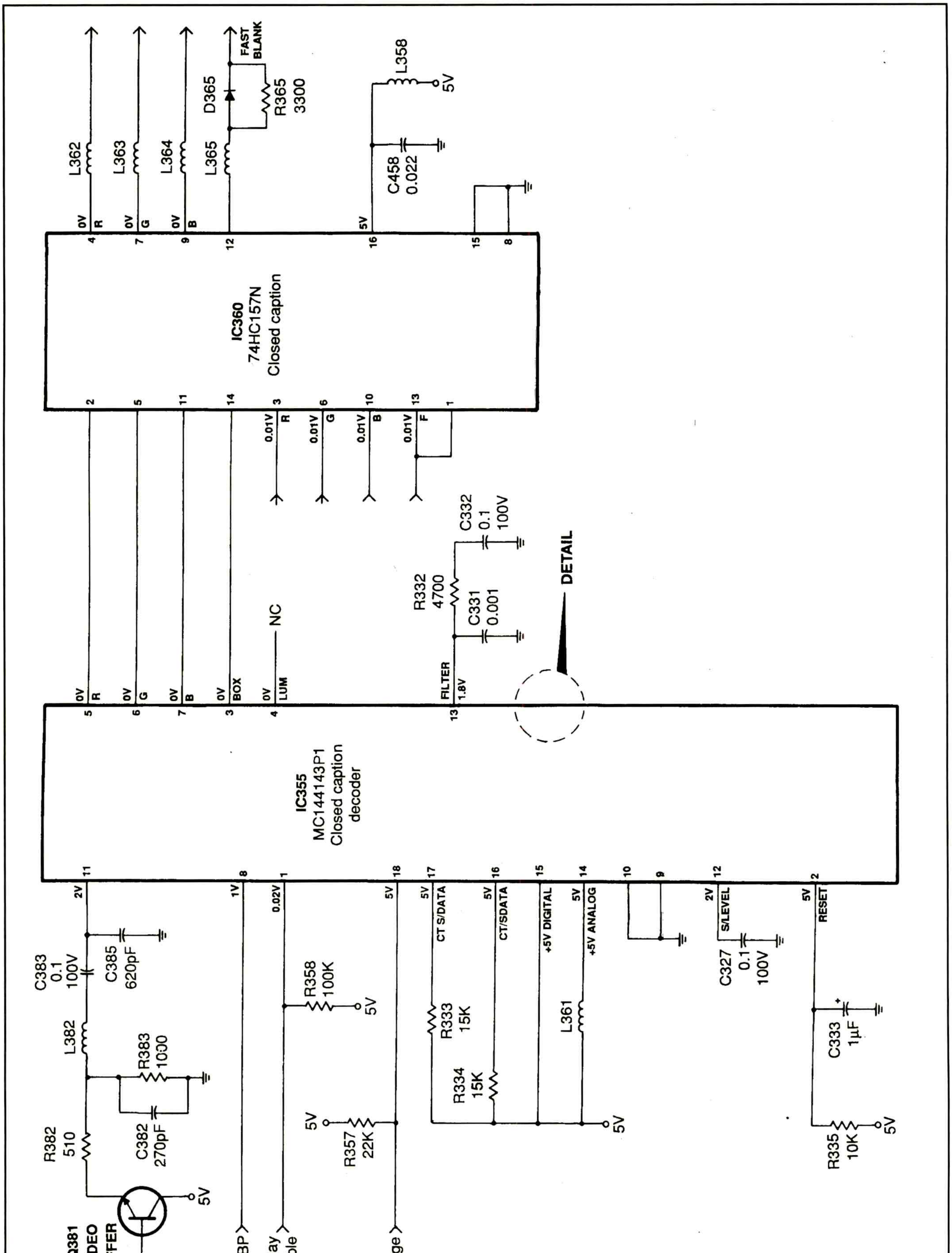



**Figure 1a.** Schematic diagram of the closed caption decoder circuit.

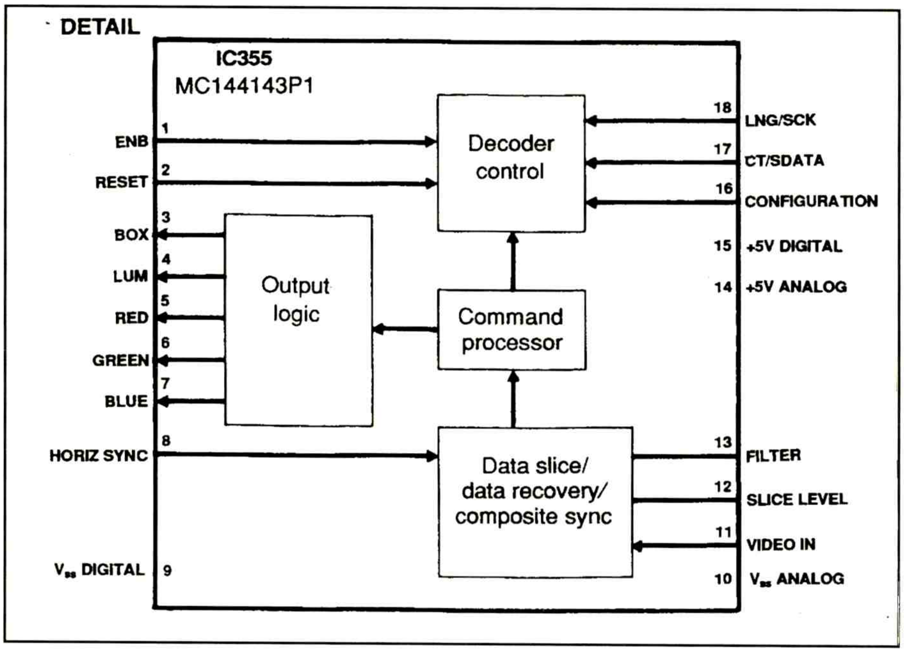



**Figure Ib.** The internal block diagram of the decoder IC will help you to understand how it functions.

up. Source 15, the supply for the entire caption circuit, is part of the secondary supply derived from the IHVT. Pins 5, 6, and 7 output the digital R, G, and B signals that bias the color amplifiers on or off as needed for character generation. Pin 3 labeled "box" outputs the F-blank or "fast blanking" signal used to blank

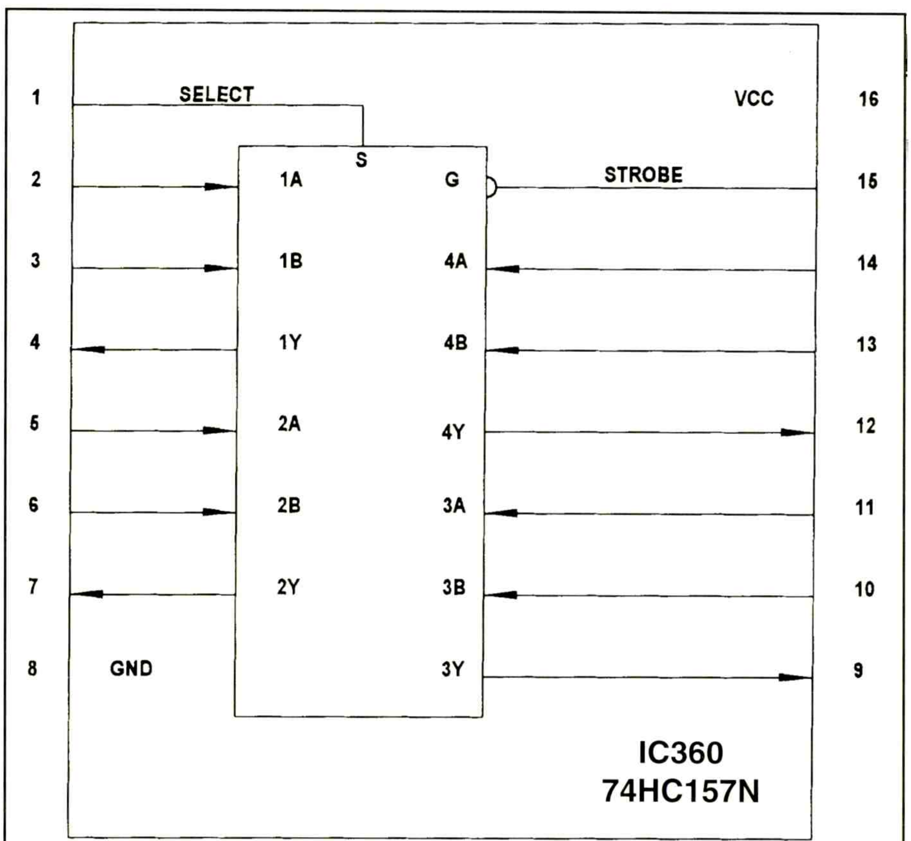



**Figure 2.** The internal diagram of the quad two-input multiplexer shows that it is essentially four A/B switches.

the normal video during captioning. This creates the black box around the text. Collectively, the R, G, B, and F-blank lines can be thought of as a data bus.

## RGB signals for on-screen display

The main signal processor, IC270, is capable of receiving the RGB signals needed for On Screen Display as discussed in a previous article (see Magnavox Processor Part II, August 1999 **ES&T**). These signals are generated in the SYSCON. In this particular system, the OSD RGB bus from the SYSCON, IC345 (not shown), is connected to IC360, a quad dual-input multiplexer. The RGB bus from the caption decoder is also connected to IC360. Another data bus at the output of IC360 is connected to the TV chip.

The internal breakdown of IC360 is shown in Figure 2. This is a standard TTL logic chip and can be thought of as four A/B switches. Each switch has one A input, one B input, and one output designated Y. The states of all switches are controlled by the "select" input, pin 1. Note that the select pin is tied to pin 13 which is the F-blank line from the SYSCON. The F-blank signal is active anytime RGB data is being sent.

When the RGB bus from the SYSCON is active, the select pin goes high causing the B inputs to be selected or connected to the Y outputs. In other words, the OSD bus has priority. When OSD is inactive the select pin goes low resulting in selection of the A inputs. With the A inputs selected, caption information passes to the TV chip.

The F-blank line from IC360 pin 12 is connected to the blanking input of the TV chip. A flyback pulse is also applied to the blanking input. This is needed for regular blanking of the beam during the horizontal retrace interval where no video information exists. Diode D365 prevents the FBP from entering IC360.

## Troubleshooting

Troubleshooting should not be difficult now that you understand how the basic closed-caption system works. First check obvious possibilities such as the 5V supply voltage, source #15. It is unlikely that this source will be down if the TV has a picture for the following reason. The video IF section of the TV

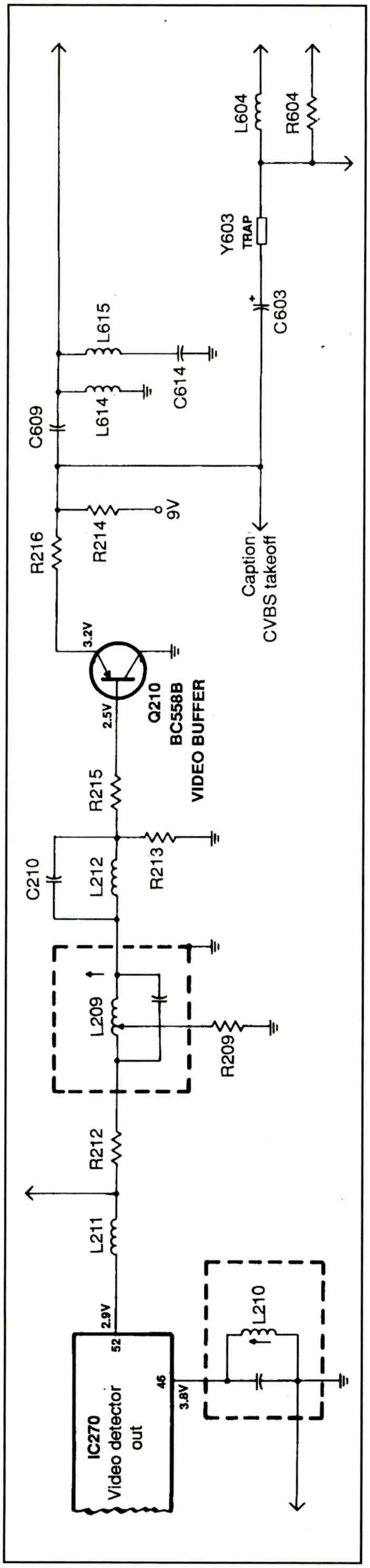



**Figure 3.** The CVBS signal from pin 52 of the main signal processor or "TV chip" passes through a video buffer and a chroma trap before it reaches the caption take-off point.

chip uses source #14. Both sources have a common 5V regulated source. Any failure of this source will disable the IF section, eliminating all video. Each of these sources, however, has a fusible resistor after the regulator. If R457 (not shown) opens, captioning will be lost while the video will be normal. In a case where R457 is found to be open, it is almost certain that something in the caption circuit is loading the supply. The normal resistance measurement from either side of R457 to ground should be around 6.5 K.

If OSD is operational it is likely that IC360 is okay since it passes data to the TV chip. If OSD and captioning are both inoperative, IC360 is suspect since it is common to both. If captioning is down but OSD is normal, scope pin 11 of IC355. A more convenient point to attach a probe in order to view this signal is L382, located adjacent to the IC. You should be able to find a normal CVBS waveform.

With the scope timebase set for 2ms you should observe a signal of just under $2V_{PP}$. If not, simply trace the signal path back through the buffer amp and chroma trap to the take-off point in the video signal path. Suspect any component or stage that is not passing the signal. Problems in any stage ahead of the take-off point will affect video and captioning.

If the CVBS signal is okay, check for a FBP at pin 8. Check pin 1 for low-to-high transitions when the caption function is turned on and off. Is the SYSCON trying to turn on the caption decoder? If IC355 has the proper supply voltage and input signals but will not generate the correct output signals, it must be suspect. In this case, replacement is the only alternative.

This article illustrates one way in which digital circuits are being used in television. In addition to learning how closed captioning works, you are gaining some understanding of digital circuits in general. This knowledge will be helpful as you begin to work on televisions that increasingly rely on digital electronics. ■

# Measuring ground resistance

**by the ES&T Staff**
Based on a brochure from AEMC

One of the steps in installing a satellite TV system is the installation of the grounding system. One procedure for this is to hammer a copper rod into the soil and connect the grounding point on the antenna to the ground with an appropriate conductor. Many consumer electronics service technicians have performed this procedure.

In other cases, when a technician is installing or servicing an electronics product or system, part of the procedure is to connect to an existing grounding system, or to check the effectiveness of the ground. If the system ground is not properly installed there is a danger of damage to the system as a result of overvoltage due to surges or spikes on the power line, or damage or destruction of components as a result of a nearby lightning strike. There is also potential for injury to people if the ground is not properly installed, as overcurrent devices might not open properly if there is no ground path.

But how do you know if the point to which you're connecting is really at earth ground potential? We more or less take it for granted, but if, for example, the soil is very dry, and has pulled away from the ground rod, there may be a large resistance in the ground path.

| Soil | Resistivity (approx), Ω-cm Min. | Average | Max. |
|---|---|---|---|
| Ashes, cinders, brine, waste | 590 | 2,370 | 7,000 |
| Clay, shale, gumbo, loam | 340 | 4,060 | 16,300 |
| Same, with varying proportions of sand and gravel | 1,020 | 15,800 | 135,000 |
| Gravel, sand, stones with little clay or loam | 59,000 | 94,000 | 458,000 |

**Figure 1.**

| Moisture content % by weight | Resistivity Ω-cm Top soil | Sandy loam |
|---|---|---|
| 0 | $>10^9$ | $>10^9$ |
| 2.5 | 250,000 | 150,000 |
| 5 | 165,000 | 43,000 |
| 10 | 53,000 | 18,500 |
| 15 | 19,000 | 10,500 |
| 20 | 12,000 | 6,300 |
| 30 | 6,400 | 4,200 |

**Figure 2.**

### Soil resistivity

One way to check the effectiveness of a ground is to measure the resistivity of the soil. If the installer locates the grounding system in the area of lowest soil resistivity he will achieve the most economical grounding installation. This article may include more information than the average consumer electronics technician needs to know about grounds and soil resistivity, but possession of this knowledge will certainly provide a deeper understanding of the subject, and possibly help insure the safety of electronics products and systems, and their users. Moreover, it demonstrates that there are quantitative methods available that will allow technicians to determine the effectiveness of a ground system, and not simply install the ground and hope for the best.

### Effects of soil resistivity on ground electrode resistance

Soil resistivity is the key factor that determines what the resistance of a grounding electrode will be, and to what depth it must be driven to obtain low ground resistance. The resistivity of the soil varies widely throughout the world and changes seasonally. Soil resistivity is determined largely by its content of electrolytes, which consist of moisture, minerals and dissolved salts. A dry soil has high resistivity if it contains no soluble salts (Figure 1).

### Factors affecting soil resistivity

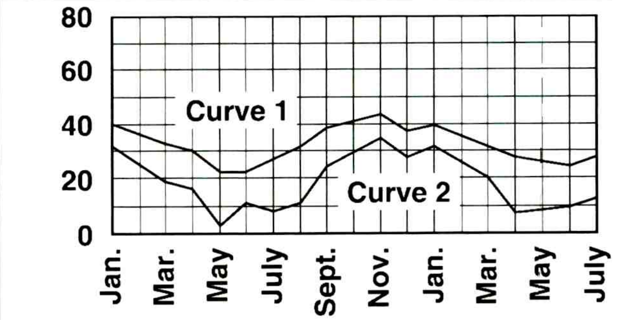
Two samples of soil, when thoroughly dried, may in fact become very good insulators having a resistivity in excess of $10^9$ ohm-centimeters. The resistivity of the soil sample is seen to change quite rapidly until approximately 20% or greater moisture content is reached (Figure 2).

The resistivity of the soil is also influenced by temperature. Figure 3 shows the variation of the resistivity of sandy loam, containing 15.2% moisture, with temperature changes from 20degreesC to -15degreesC. In this temperature range the resistivity is seen to vary from 7200 to 30,000 ohm-centimeters.

Because soil resistivity directly relates to moisture content and temperature, it is reasonable to assume that the resistance of any grounding system will vary throughout the different seasons of the year. Such variations are shown in Figure 4. Since both temperature and moisture content become more stable at

| Temperature C | F | Resistivity Ohm-cm |
|---|---|---|
| 20 | 68 | 7,200 |
| 10 | 50 | 9,900 |
| 0 | 32 (water) | 13,800 |
| 0 | 32 (ice) | 30,000 |
| -5 | 23 | 79,000 |
| -15 | 14 | 330,000 |

**Figure 3.**




Seasonal variation of earth resistance with an electrode of 3/4 inch pipe in rather stony clay soil. Depth of electrode in earth is 3 ft. for Curve 1, and 10 ft. for Curve 2

**Figure 4.**

**THE EFFECT OF SALT* CONTENT ON THE RESISTIVITY OF SOIL**

(Sandy loam, Moisture content, 15% by weight, Temperature, 17°C)

| Added Salt (% by weight of moisture) | Resistivity (Ohm-centimeters) |
|---|---|
| 0 | 10,700 |
| 0.1 | 1,800 |
| 1.0 | 460 |
| 5 | 190 |
| 10 | 130 |
| 20 | 100 |

**Figure 5.**

greater distances below the surface of the earth, it follows that a grounding system, to be most effective at all times, should be constructed with the ground rod driven down a considerable distance below the surface of the earth. Best results are obtained if the ground rod reaches the water table.

In some locations, the resistivity of the earth is so high that low-resistance grounding can be obtained only at considerable expense and with an elaborate grounding system. In such situations, it may be economical to use a ground rod system of limited size and to reduce the ground resistivity by periodically increasing the soluble chemical content of the soil.

Figure 5 shows the substantial reduction in resistivity of sandy loam brought about by an increase in chemical salt content. Chemically treated soil is also subject to considerable

**THE EFFECT OF TEMPERATURE ON THE RESISTIVITY OF SOIL CONTAINING SALT***

(Sandy loam, 20% moisture. Salt 5% of weight of moisture)

| Temperature (Degrees C) | Resistivity (Ohm-centimeters) |
|---|---|
| 20 | 110 |
| 10 | 142 |
| 0 | 190 |
| -5 | 312 |
| -13 | 1,440 |

**Figure 6.**

variation of resistivity with temperature changes, as shown in Figure 6. If salt treatment is employed, it is necessary to use ground rods that will resist chemical corrosion.

### Soil resistivity measurements (4-point measurement)

Resistivity measurements are of two types; the 2-point and the 4-point method. The 2-point method is simply the resistance measured between two points. For most applications the most accurate method is the 4-point method, which is used in the Model 4610 or Model 4500 Ground Tester manufactured by AEMC. The 4-point method (Figures 7 and 8), as the name implies, requires the insertion of four equally spaced and in-line electrodes into the test area. A known current from a constant current generator is passed between the outer electrodes. The potential drop (a function of the resistance) is then measured across the two inner electrodes. These testers are calibrated to read directly in ohms.

Equation for resistivity goes here:

$$\rho = \frac{4\pi AR}{1 + \dfrac{2A}{\sqrt{(A^2 + 4B^2)}} - \dfrac{2A}{\sqrt{(4A^2 + 4B^2)}}}$$

Where: A = distance between the electrodes in centimeters
B = electrode depth in centimeters

If A > 20 B, the formula becomes:
$\rho = 2\pi$ AR (with A in cm)
$\rho = 191.5$ AR (with A in feet)
$\rho$ = Soil resistivity (ohm-cm)
This value is the average resistivity of the ground at a depth equivalent to the distance "A" between two electrodes.

### Soil resistivity measurements

Given a sizable tract of land in which to determine the optimum soil resistivity some intuition is in order. Assuming that the objective is low resistivity, preference should be given to an area containing moist loam as opposed to a dry sandy area. Consideration must also be given to the depth at which resistivity is required.

Here's an example. After inspection, the area investigated has been narrowed down to a plot of ground approximately 75 square feet ($7m^2$). Assume that you need to determine the resistivity at a depth of 15 feet (450 cm). The distance "A" between the electrodes must then be equivalent to the depth at

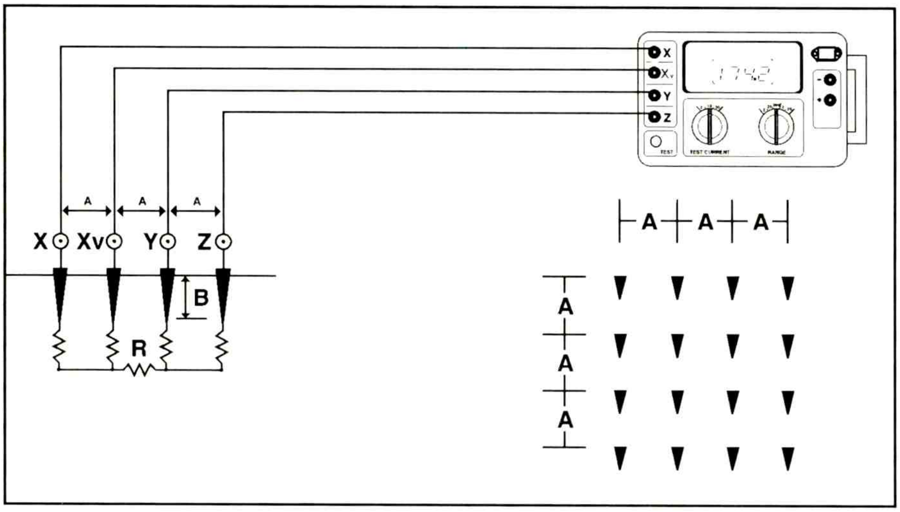
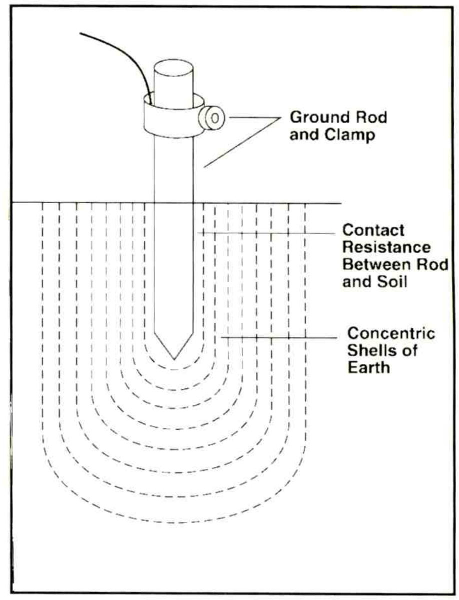



Figure 7 and 8.

Figure 9.




which average resistivity is to be determined (15 ft, or 450 cm). Using the more simplified Wenner formula (r = 2piAR), the electrode depth must then be 1/20th of the electrode spacing or 8-7/8 inches (22.5 cm).

Lay out the electrodes in a grid pattern and connect to the resistivity meter as shown in Figure 8. Proceed as follows:

1 Remove the shorting link between X and Xv (C1, P1)

1 Connect all four auxiliary rods (Figure 7)

For example, if the reading is R = 15

rho (resistivity) = 2pi x A x R

A (distance between electrodes) = 450cm

rho = 6.28 x 15 x 450 = 42,390 ohm-cm

### Ground electrodes

The term "ground" is defined as a conducting connection by which a circuit or equipment is connected to the earth. The connection is used to establish and maintain as closely as possible the potential of the earth on the circuit or equipment connected to it. A "ground" consists of a grounding conductor, a bonding connector, its grounding electrode(s), and the soil in contact with the electrode.

Grounds have several protection applications. For natural phenomena such as lightning, grounds are used to discharge the system of current before personnel can be injured or system components damaged. For foreign potentials due to faults in electric power systems with ground returns, grounds help ensure rapid operation of the protection relays by providing low resistance fault current paths. This provides for the removal of the foreign potential as quickly as possible. The ground should drain the foreign potential before personnel are injured and the power or communications system is damaged.

Ideally, to maintain a reference potential for instrument safety, protect against static electricity, and limit the system to frame voltage for operator safety, a ground resistance should be zero ohms. In reality, as we describe further in the text, this value cannot be obtained.

Last but not least, low ground resistance is essential to meet NEC (National Electrical Code), OSHA (Occupational Safety and Health Administration) and other electrical safety standards.

Figure 9 illustrates a grounding rod. The resistance of the electrode has the following components:

(A) the resistance of the metal and that of the connection to it.

(B) the contact resistance of the surrounding earth to the electrode.

(C) the resistance in the surrounding earth to current flow or earth resistivity which is often the most significant factor.

More specifically:

(A) Grounding electrodes are usually made of a very conductive metal (copper or copper clad) with adequate cross-sections so that the overall resistance is negligible.

(B) The National Institute of Standards and Technology has demonstrated that the resistance between the electrode and the surrounding earth is negligible if the electrode is free of paint, grease, or other coating, and if the earth is firmly packed.

(C) The only component remaining is the resistance of the surrounding earth. The electrode can be thought of as being surrounded by concentric shells of earth or soil, all of the same thickness. The closer the shell is to the electrode, the smaller its surface; hence, the greater its resistance. The farther away the shells are from the electrode, the greater the surface of the shell; hence, the lower the resistance. Eventually, adding shells at a distance from the grounding electrode will no longer noticeably affect the overall earth resistance surrounding the electrode. The distance at which this effect occurs is referred to as the effective resistance area and is directly dependent on the depth of the grounding electrode.

In theory, the ground resistance may be derived from the general formula:

$$R = \frac{\rho L}{A} \quad \text{Resistance} = \text{Resistivity} \times \frac{\text{Length}}{\text{Area}}$$

This formula illustrates why the shells of concentric earth decrease in resistance the farther they are from the ground rod:

$$R = \text{Resistivity of Soil} \times \frac{\text{Thickness of Shell}}{\text{Area}}$$

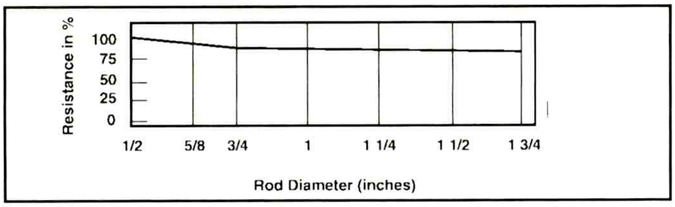



**Figure 10.**

In the case of ground resistance, uniform earth (or soil) resistivity throughout the volume is assumed, although this is seldom the case in nature. The equations for systems of electrodes are very complex and often expressed only as approximations. The most commonly used formula for single ground electrode systems, developed by Professor H. R. Dwight of the Massachusetts Institute of Technology, is the following:

$$R = \frac{\rho}{2\pi L} \times \frac{\{(\ln 4L) - 1\}}{r}$$

R = resistance in ohms of the ground rod to the earth (or soil)

L = grounding electrode length

r = grounding electrode radius

$\rho$ = average resistivity in ohms-cm.

### Effect of ground electrode size and depth on resistance

*Size*: Increasing the diameter of the rod does not materially reduce its resistance. Doubling the diameter reduces resistance by less than 10% (Figure 10).

*Depth*: As a ground rod is driven deeper into the earth, its resistance is substantially reduced. In general, doubling the rod length reduces the resistance by an additional 40% (Figure 11). The NEC (1987, 250-83-3) requires a minimum of 8 ft (2.4 m) to be in contact with the soil. The most common is a 10 ft (3 m) cylindrical rod, which meets the NEC code. A minimum diameter of 5/8 inch (1.59 cm) is required for steel rods and 1/2 inch (1.27 cm) for copper or copper clad steel rods (NEC 1987, 250-83-2). Minimum practical diameters for driving limitations for 10 ft (3 m) rods are:

1 1/2 inch (1.27 cm) in average soil

1 5/8 inch (1.59 cm) in moist soil

1 3/4 inch (1.91 cm) in hard soil or more than 10 ft driving depths

### Ground resistance values

Following is the wording of the NEC 250-84 (1987) requirement for resistance of man-made electrodes. "A single electrode consisting of a rod, pipe, or plate that does not have a resistance to ground of 25 ohms or less shall be augmented by one additional rod of any of the types specified in section 250-81 or 250-83. Where multiple rod, pipe or plate electrodes are installed to meet the requirements of this section, they shall be not less than 6 ft (1.83 m) apart."

The National Electrical Code (NEC) states that the resistance to ground shall not exceed 25 ohms. This is an upper limit and guideline, since much lower resistance is required in many instances to assure an adequate ground.

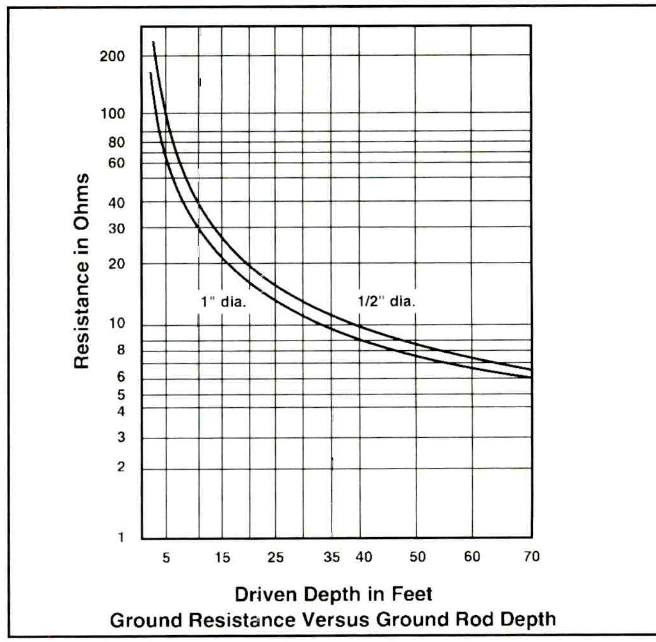



**Figure 11.**

"How low in resistance should a ground be?" An arbitrary answer to this in ohms is difficult. The lower the ground resistance, the safer; and for positive protection of personnel and equipment, it is worth the effort to aim for less than one ohm. It is generally impractical to reach such a low resistance along a distribution system or a transmission line or in small substations. In some regions, resistances of 5 ohms or less may be obtained without much trouble.

In other regions, it may be difficult to bring resistance of driven grounds below 100 ohms. Accepted industry standards stipulate that transmission substations should be designed not to exceed 1ohm. In distribution substations, the maximum recommended resistance is for 5 ohms or even 1 ohm. In most cases, the buried grid system of any substation will provide the desired resistance.

In light industrial or in telecommunication central offices, 5ohm is often the accepted value of ground resistance. For lightning protection, the arrestors should be coupled with a maximum ground resistance of 1ohm.

These parameters can usually be met with the proper application of basic grounding theory (See the nomograph of Figure 12 for more detail). There will always exist circumstances that will make it difficult to obtain the ground resistance required by the NEC or other safety standards. When these situations develop, several methods of lowering the ground resistance can be employed. These include parallel rod systems, deep driven rod systems utilizing sectional rods, and chemical treatment of the soil. Additional methods discussed in other published data are buried plates, buried conductors (counterpoise), electrically connected building steel, and electrically connected concrete reinforced steel.

Electrically connecting to existing water and gas distribution systems was often considered to yield low ground resistance; however, recent design changes in these systems utilizing non-metallic pipes and insulating joints have made this method of obtaining a low resistance ground questionable and in many instances unreliable.

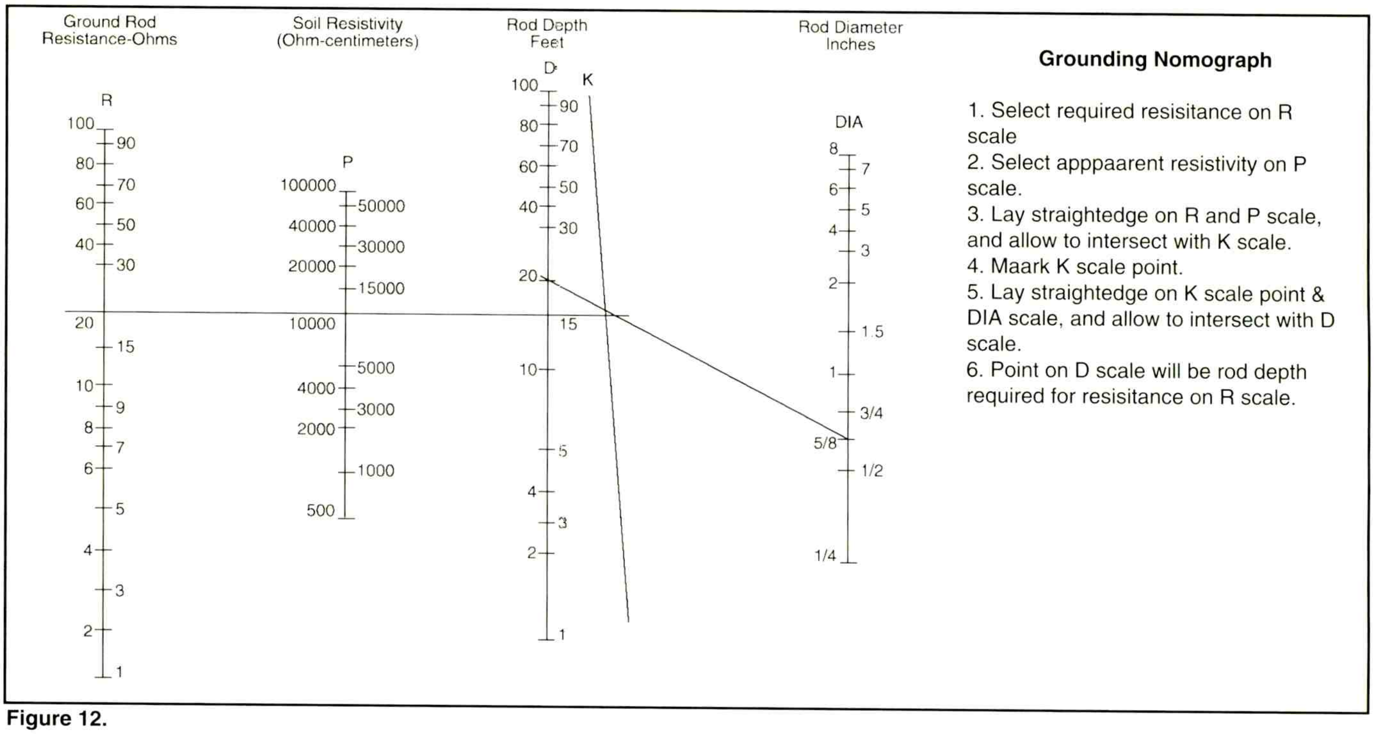



**Figure 12.**

The measurement of ground resistances may only be accomplished with specially designed test equipment. Most instruments use the fall-of-potential principle of alternating current circulating between an auxiliary electrode and the ground electrode under test. The reading will be given in ohms, and represents the resistance of the ground electrode to the surrounding earth.

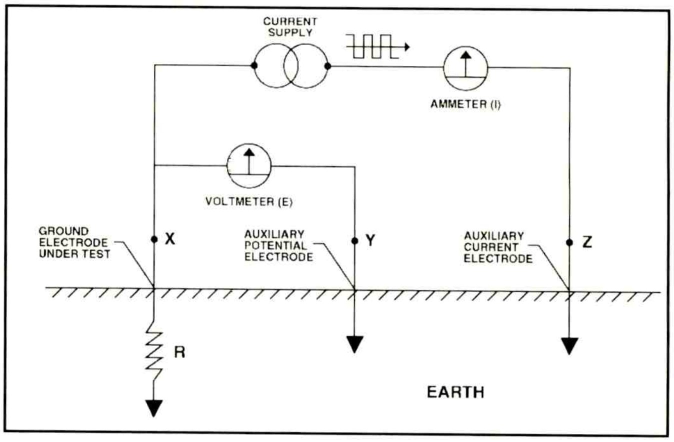



**Figure 13.**

### Ground resistance testing principle

(Fall of Potential — 3-Point Measurement)

The potential difference between rods X and Y is measured by a voltmeter, and the current flow between rods X and Z is measured by an ammeter. (Note: X, Y and Z may be referred to as X, P and C in a 3-point tester or C1, P2 and C2 in a 4-point tester.) (Figure 13.)

By Ohm's Law E = RI or R = E/I, we may obtain the ground electrode resistance R. If E = 20 V and I = 1 A, then

$$R = E/I = 20/1 = 20$$

It is not necessary for the user to carry out all the measurements when using a ground tester. The ground tester will measure directly by generating its own current and displaying the resistance of the ground electrode.

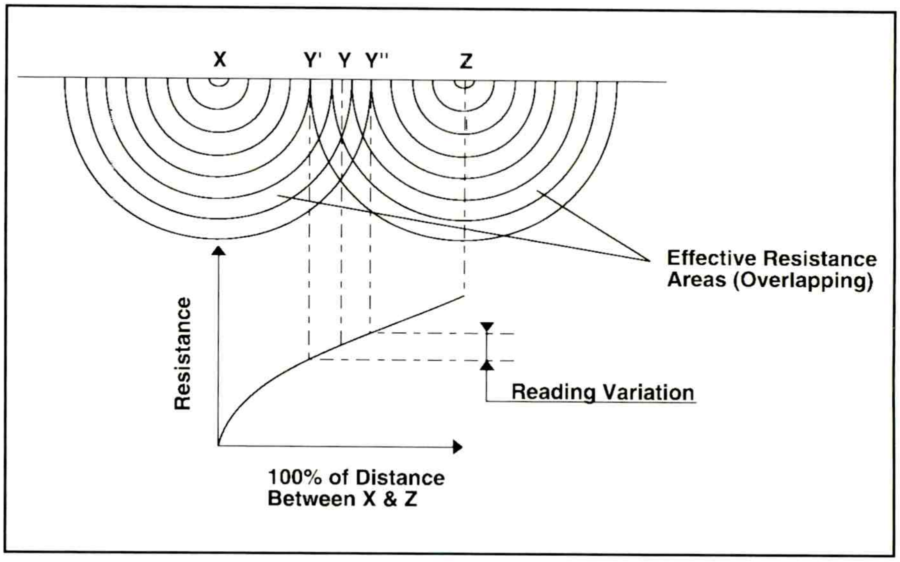



**Figure 14.**

### Position of the auxiliary electrodes on measurements

The goal in precisely measuring the resistance to ground is to place the auxiliary current electrode Z far enough from the ground electrode under test so that the

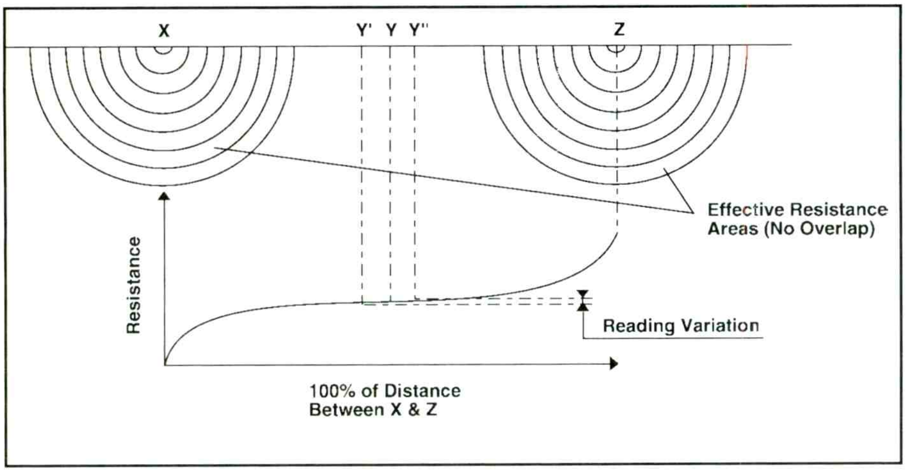



Figure 15.

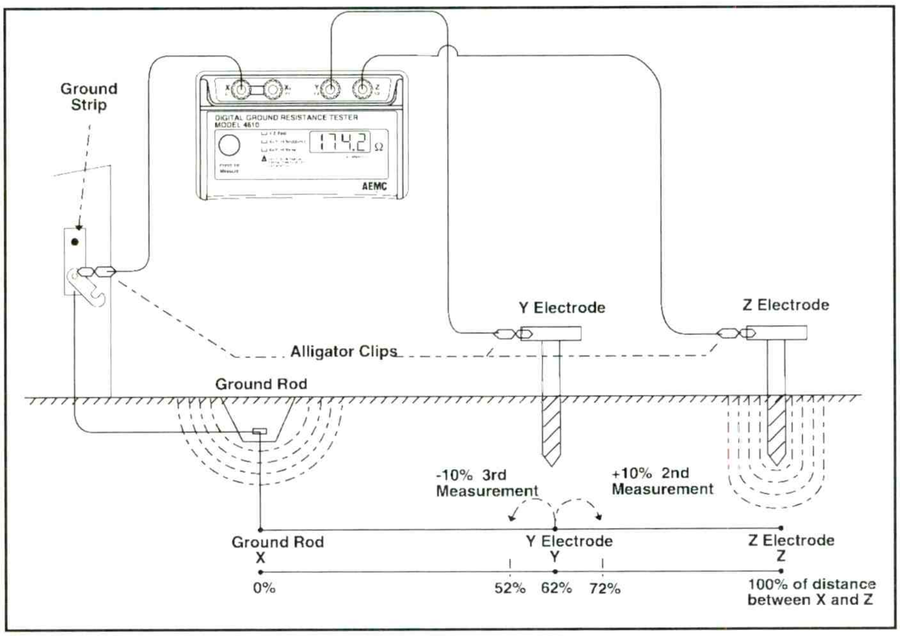



Figure 16.

auxiliary potential electrode Y will be outside of the effective resistance areas of both the ground electrode and the auxiliary current electrode. The best way to find out if the auxiliary potential rod Y is outside the effective resistance areas is to move it between X and Z and to take a reading at each location. If the auxiliary potential rod Y is in an effective resistance area (or in both if they overlap, as in Figure 14), by displacing it the readings taken will vary noticeably in value. Under these conditions, no exact value for the resistance to ground may be determined.

On the other hand, if the auxiliary potential rod Y is located outside of the effective resistance areas (Figure 15), as Y is moved back and forth the reading variation is minimal. The readings taken should be relatively close to each other, and are the best values for the resistance to ground of the ground X. The readings should be plotted to ensure that they lie in a "plateau" region as shown in Figure 15. The region is often referred to as the "62% area."

### Measuring resistance of ground electrodes (62% method)

The 62% method has been adopted after graphical consideration and after actual test. It is the most accurate method but is limited by the fact that *the ground tested is a single unit.* This method applies only when all three electrodes are in a straight line and the ground is a *single* electrode, pipe, or plate, etc., as in Figure 16.

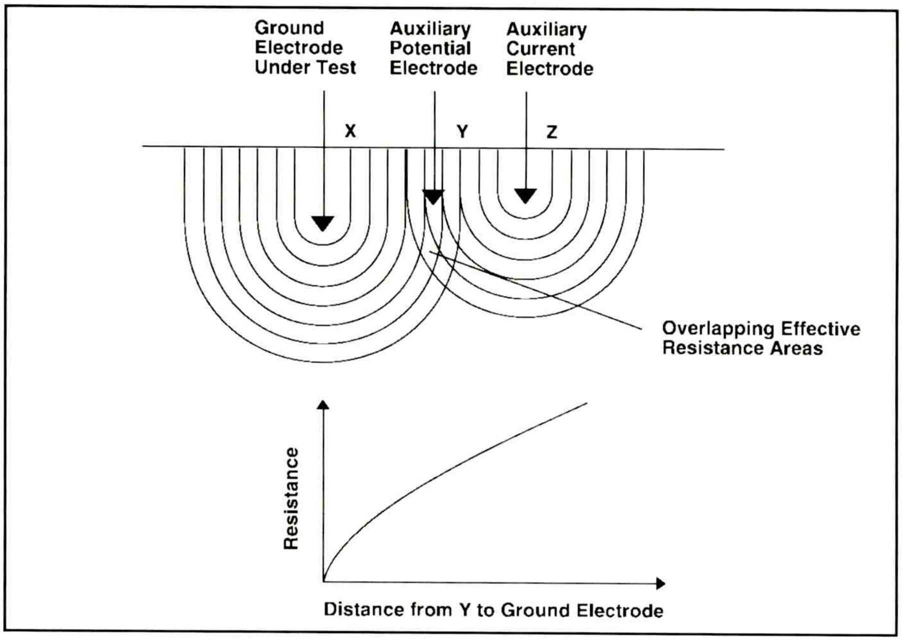



Figure 17.

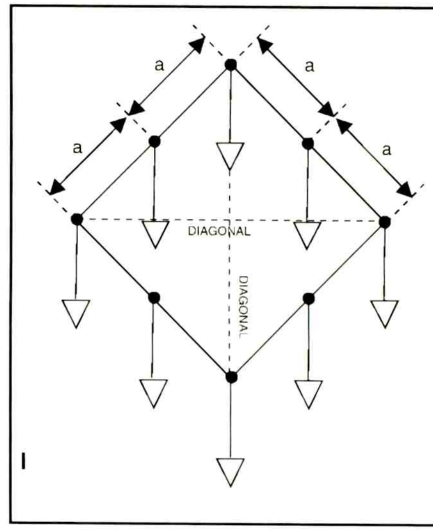



Figure 19.

Consider Figure 17, which shows the effective resistance areas (concentric shells) of the ground electrode X and of the auxiliary current electrode Z. The resistance areas overlap. If readings were taken by moving the auxiliary potential electrode Y towards either X or Z, the reading differentials would be great and one could not obtain a reading.

Now consider Figure 18, where the X and Z electrodes are sufficiently spaced so that the areas of effective resistance do not overlap. If we plot the resistance measured we find that the measurements level off when Y is placed at 62% of the distance from X to Z, and that the readings on either side of the initial Y setting are most likely to be within the established tolerance band. This tolerance band is defined by the user and expressed as a percent of the initial reading: ± 2%, ± 5%, ± 10%, etc.

### Auxiliary electrode spacing

No definite distance between X and Z can be given, since this distance is relative to the diameter of the electrode tested, its length, the homogeneity of the soil tested, and particularly, the effective resistance areas. However, an approximate distance may be determined by referring to an available chart for a homogeneous soil and an electrode of 1 inch in diameter. (For a diameter of 1/2 inch, reduce the distance by 10%; for a diameter of 2 inch increase the distance by 10%.)

### Multiple electrode system

A single driven ground electrode is an economical and simple means of making a good ground system. But sometimes a single rod will not provide sufficient low resistance, and several ground electrodes will be driven and connected in parallel by a cable. Very often when two, three or four ground electrodes are being used, they are driven in a straight line; when four or more are being used, a hollow square configuration is used and the ground electrodes are still connected in parallel and are equally spaced (Figure 19).

In multiple electrode systems, the 62% method electrode spacing may no longer be applied directly. The distance of the auxiliary electrodes is now based on the maximum grid distance (i.e. in a square, the diagonal; in a line, the total length. For example, a square having a side of 20 ft will have a diagonal of approximately 28 ft).

### Two-point measurement (simplified method)

This is an alternative method *when an excellent ground is already available.* In congested areas where finding room to drive the two auxiliary rods may be a

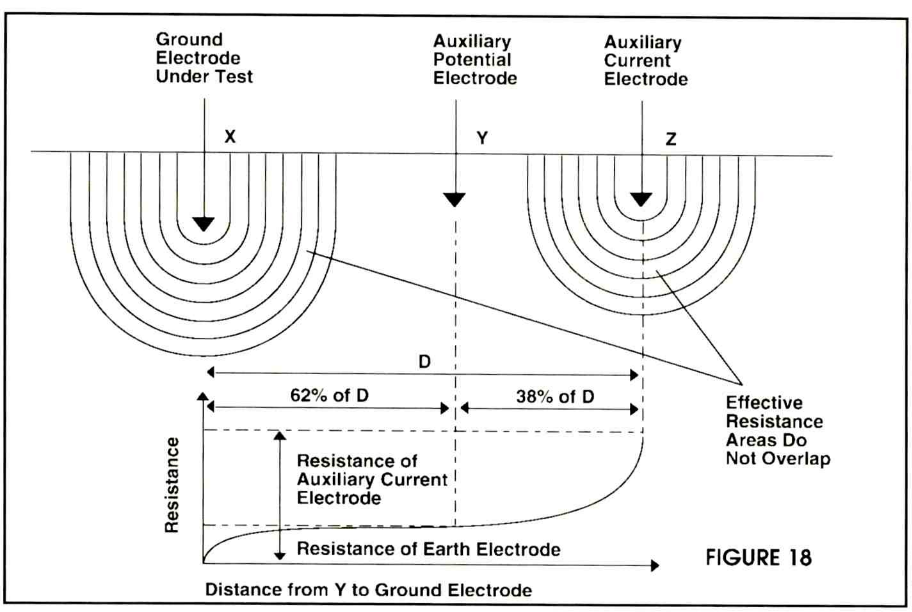



Figure 18.

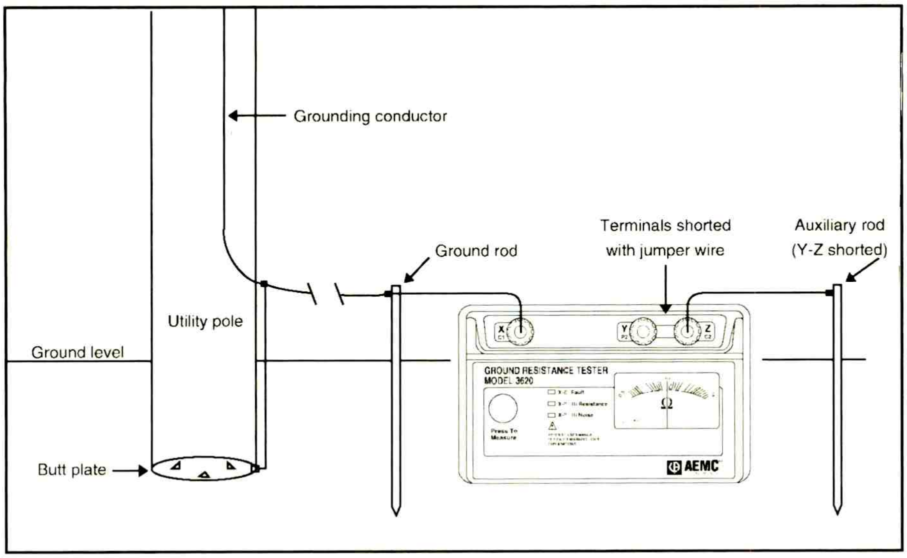



**Figure 20.**

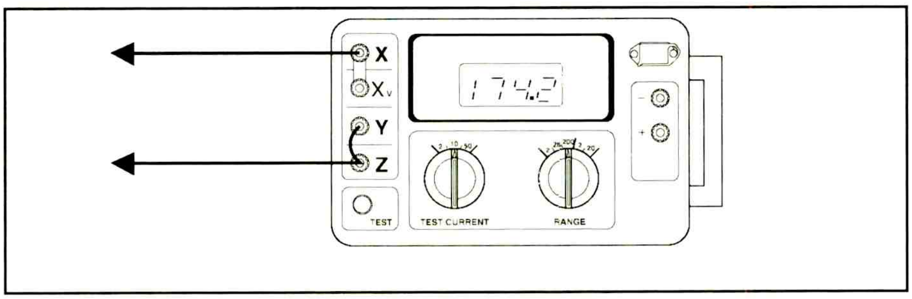



**Figure 21.**

problem, the two-point measurement method may be applied. The reading obtained will be that of the two grounds in series. Therefore, the water pipe or other ground must be very low in resistance so that it will be negligible in the final measurement. The lead resistances will also be measured and should be deducted from the final measurement.

This method is not as accurate as three-point methods (62% method), as it is particularly affected by the distance between the tested electrode and the dead ground or water pipe. This method

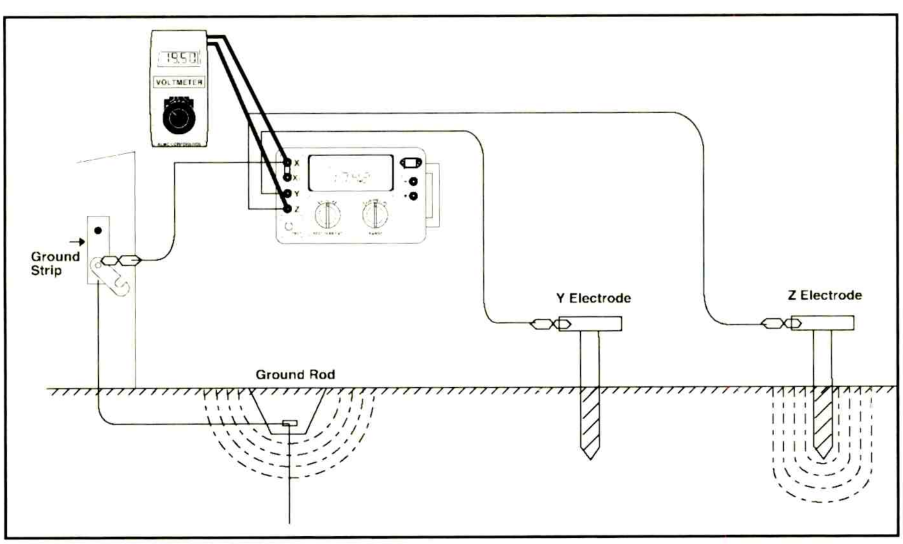



**Figure 22.**

# Books

***Ham Radio Operator's Guide* by Carl Bergquist, 320 pages, $29.95**

What kind of exciting and challenging hobby is shared by doctors, sales people, lawyers, auto mechanics, truckers, PhDs, retired civilian and military employees, homemakers, writers and a variety of others? Why HAM radio of course! The radios, antennas, and frequencies are an important part of HAM radio, but it is the people that make it truly special. It is their commitment and adoration for the hobby that makes it rewarding. The opportunity to meet people from all walks of life — and even all parts of the world — who share the love of HAM radio is what makes it well worth becoming a part of!

Carl Bergquist writes *Ham Radio Operator's Guide* from the perspective of a new user, while keeping the experienced operator in mind. Coverage includes getting your amateur radio license, a large section on equipment ranging from antenna types to power supplies, education, contests, clubs, safety, as well as often-overlooked topics like jargon and etiquette. Also included are instructions for several exciting construction projects such as a field strength meter, antennas, a power distribution center, and other add-ons to dress up any HAM shack.

Following a successful career as a photojournalist for AP, UPI, The New York Times, Newsweek, and other publications, author Carl J. Bergquist turned his efforts toward his lifelong hobby of electronics, publishing articles in electronics hobbyist magazines.

PROMPT Publications, 5436 West 78th Street, P.O. Box 681008, Indianapolis, IN 46268

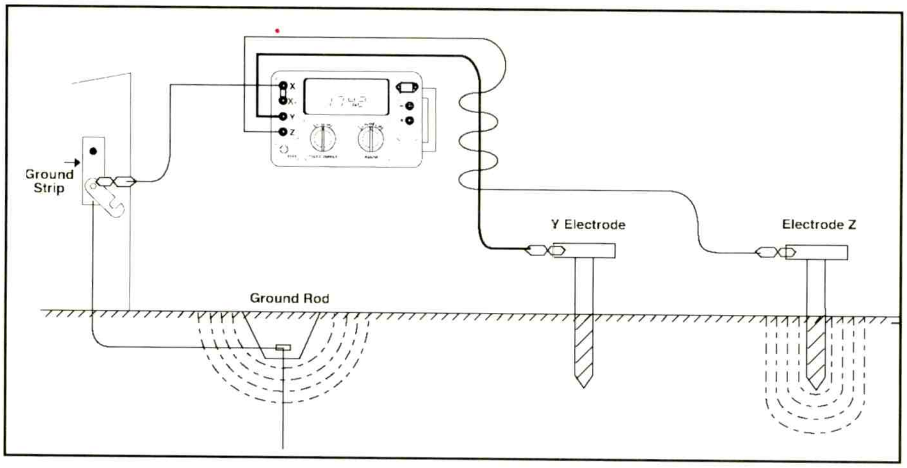



Figure 23.

should not be used as a standard procedure, but rather as a back-up in tight areas. See Figure 20.

### Continuity measurement

Continuity measurements of a ground conductor are possible by using two terminals (Figure 21).

### Excessive noise

Excessive noise may interfere with testing because of the long leads used to perform a fall-of-potential test. A voltmeter can be utilized to identify this problem. Connect the "X", "Y" and "Z" cables to the auxiliary electrodes as for a standard ground resistance test. Use the voltmeter to test the voltage across terminals "X" and "Z" (Figure 22).

The voltage reading should be within stray voltage tolerances acceptable to your ground tester. If the voltage exceeds this value, try the following techniques:

A) Braid the auxiliary cables together. This often has the effect of canceling out the common mode voltages between these two conductors (Figure 23).

B) If the previous method fails, try changing the alignment of the auxiliary cables so that they are not parallel to power lines above or below the ground (Figure 24).

C) If a satisfactory low voltage value is still not obtained, the use of shielded cables may be required. The shield acts to protect the inner conductor by capturing the voltage and draining it to ground (Figure 25).

1. Float the shields at the auxiliary electrodes.
2. Connect all three shields together at (but not to) the instrument.
3. Solidly ground the remaining shield to the ground under test.

### Excessive auxiliary rod resistance

The inherent function of a fall-of-potential ground tester is to input a constant current into the earth and measure the voltage drop by means of auxiliary electrodes. Excessive resistance of one or both auxiliary electrodes can inhibit this function. This is caused by high soil resistivity or poor contact between the auxiliary electrode and the surrounding dirt (Figure 26).

To ensure good contact with the earth, stamp down the soil directly around the auxiliary electrode to remove air gaps formed when inserting the rod. If soil resistivity is the problem, pour water around the auxiliary electrodes. This reduces the auxiliary

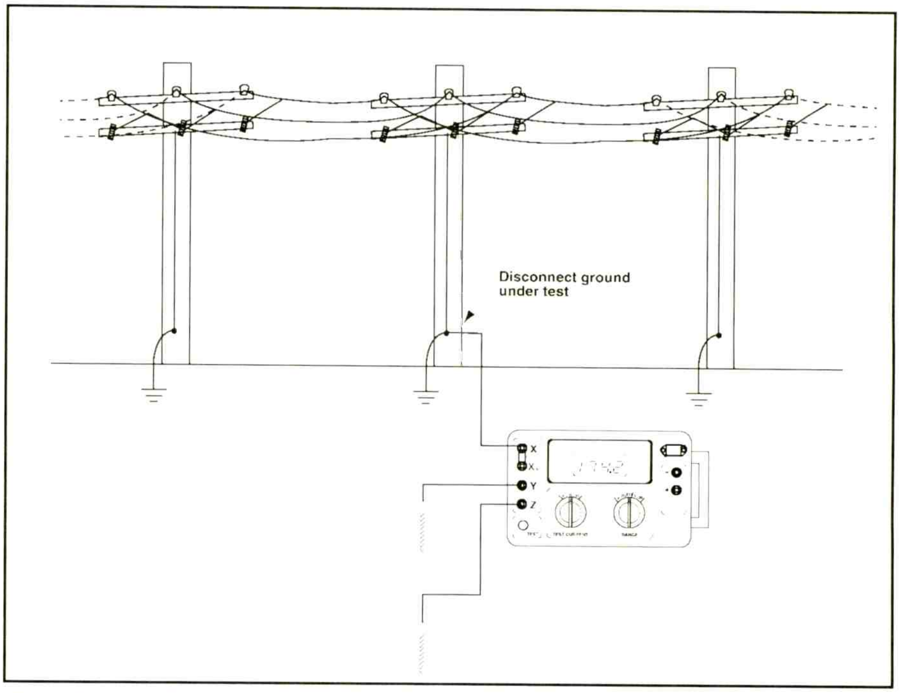



Figure 24.

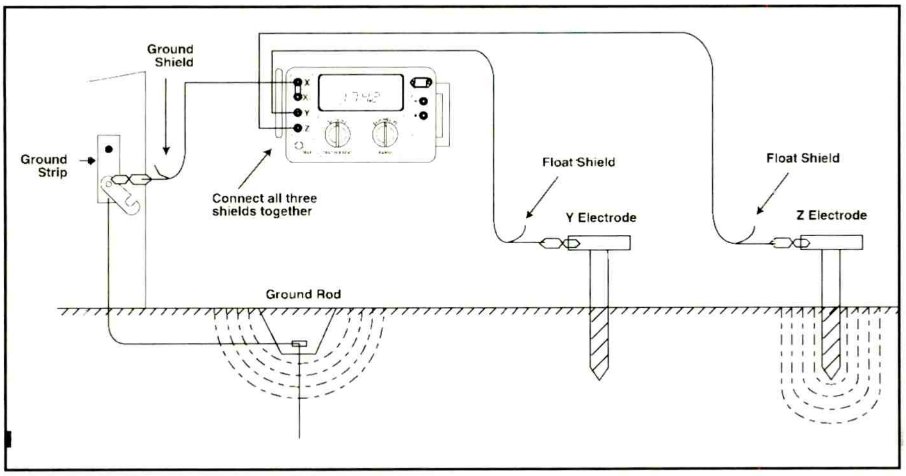



Figure 25.

electrode's contact resistance without affecting the measurement.

### Tar or concrete mat

Sometimes a test must be performed on a ground rod that is surrounded by a tar or concrete mat, where auxiliary electrodes cannot be driven easily. In such cases, metal screens and water can be used to replace auxiliary electrodes, as shown in Figure 27.

Place the screens on the floor the same distance from the ground rod under test as you would auxiliary electrodes in a standard fall-of-potential test. Pour water on the screens and allow it to

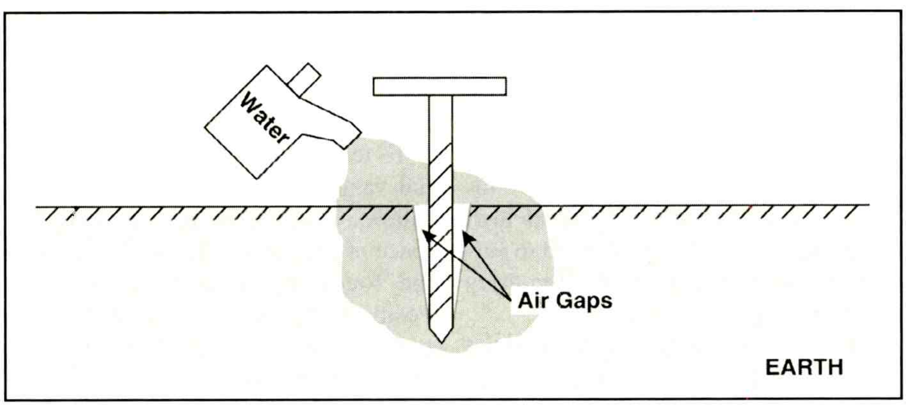



Figure 26.

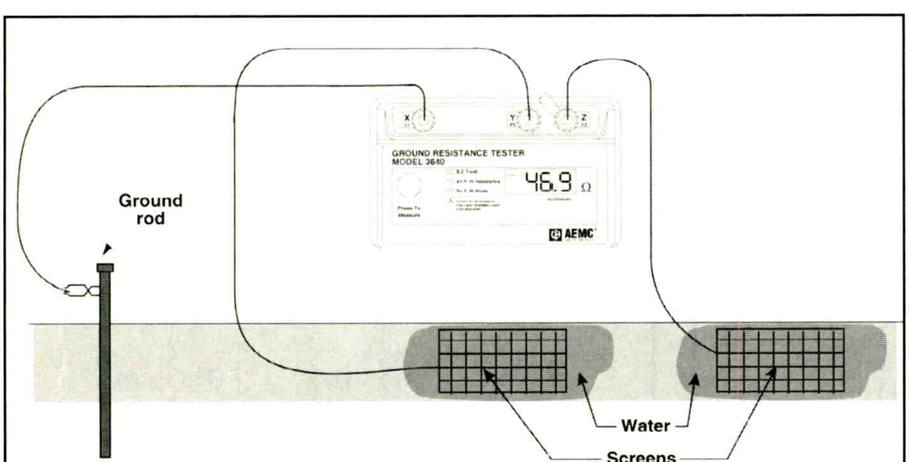



Figure 27.

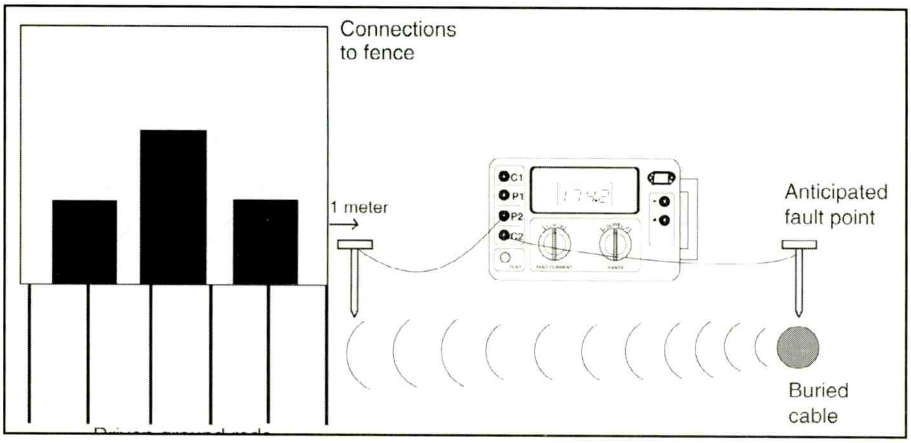



Figure 28.

soak in. These screens will now perform the same function as would driven auxiliary electrodes.

### Touch potential measurements

The primary reason for performing fall-of-potential measurements is to observe electrical safety of personnel and equipment. However, in certain circumstances the degree of electrical safety can be evaluated from a different perspective.

Periodic ground electrode or grid resistance measurements are recommended when:

1) The electrode/grid is relatively small and is able to be conveniently disconnected.

2) Corrosion induced by low soil resistivity or galvanic action is suspected.

3) Ground faults are very unlikely to occur near the ground under test.

*Touch potential measurements* are an alternative method for determining electrical safety. Touch potential measurements are recommended when:

1) It is physically or economically impossible to disconnect the ground to be tested.

2) Ground faults could reasonably be expected to occur near the ground to be tested, or near equipment grounded by the ground to be tested.

3) The "footprint" of grounded equipment is comparable to the size of the ground to be tested. (The "footprint" is the outline of the part of equipment in contact with the earth.)

Neither fall-of-potential resistance measurements nor touch potential measurements tests the ability of grounding conductors to carry high phase- to-ground fault currents. Additional high current tests should be performed to verify that the grounding system can carry these currents.

When performing touch potential measurements, a four-pole ground resistance tester is used. During the test, the instrument induces a low level fault into the earth at some proximity to the subject ground. The instrument displays touch-potential in volts per ampere of fault current. The displayed value is then multiplied by the largest anticipated ground fault current to obtain the worst-case touch potential for a given installation.

For example, if the instrument displayed a value of 0.1ohm when connected to a system where the maximum fault current was expected to be 5000 A, the maximum touch potential would be: 5000 x .1 = 500V.

Touch potential measurements are similar to fall-of-potential measurements in that both measurements require placement of auxiliary electrodes into or on top of the earth. Spacing the auxiliary electrodes during touch potential measurements differs from fall-of-potential electrode spacing, as shown in Figure 28 on the following page.

Consider the following scenario: If the buried cable depicted in Figure 28 experienced an insulation breakdown near the substation shown, fault currents would travel through the earth towards the substation ground, creating a voltage gradient. This voltage gradient may be hazardous or potentially lethal to personnel who come in contact with the affected ground.

To test for approximate touch potential values in this situation, proceed as follows: Connect cables between the fence of the substation and C1 and P1 of the four-pole earth resistance tester. Position an electrode in the earth at the point at which the ground fault is anticipated to occur, and connect it to C2.

In a straight line between the substation fence and the anticipated fault point, position an auxiliary electrode into the earth one meter (or one arm's length)

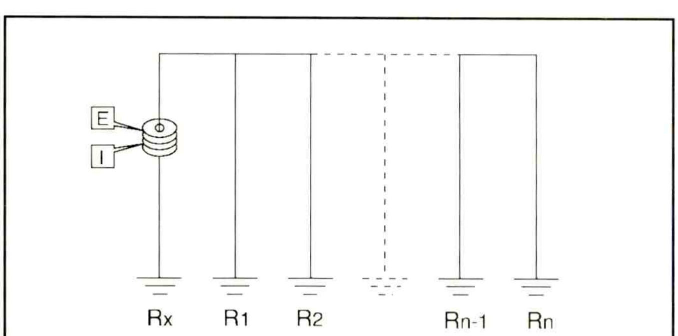



Figure 29.

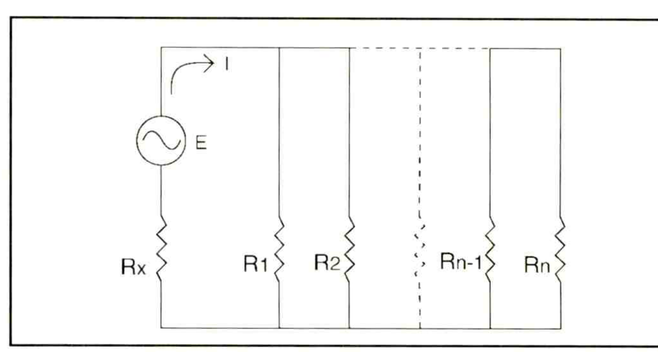



Figure 30.

away from the substation fence, and connect it to P2. Turn the instrument on, select the 10mA current range, and observe the measurement. Multiply the displayed reading by the maximum fault current of the anticipated fault.

By positioning the P2 electrode at various positions around the fence adjacent to the anticipated fault line, a voltage gradient map may be obtained.

### Clamp-on ground resistance measurement

(Models 3710 and 3730)

This measurement method is innovative and quite unique. It offers the ability to measure the resistance without disconnecting the ground. This type of measurement also offers the advantage of including the bonding to ground and the overall grounding connection resistances.

### Principle of Operation

Usually, a common distribution line grounded system can be simulated as a simple basic circuit as shown in Figure 29 or an equivalent circuit, shown in Figure 30. If voltage E is applied to any measured grounding pole Rx through a special current transformer (CT), current I flows through the circuit, thereby establishing the following equation.

$$E/I = Rx + \frac{1}{\sum_{k=1}^{n} \frac{1}{Rk}} \quad \textit{where, usually } R >> \frac{1}{\sum_{k=1}^{n} \frac{1}{Rk}}$$

***"If grounds are not properly established, all kinds of undesirable things can happen."***

Therefore, E/I = Rx is established. If I is detected with E kept constant, measured grounding pole resistance can be obtained. Refer again to Figures 29 and 30. Current is fed to a special transformer via a power amplifier from a 1.7 kHz constant voltage oscillator. This current is detected by a detection CT. Only the 1.7 kHz signal frequency is amplified by a filter amplifier. This occurs before the A/D conversion and after synchronous rectification. It is then displayed on the LCD. The filter amplifier is used to cut off both earth current at commercial frequency and high-frequency noise. Voltage is detected by coils wound around the injection CT which is then amplified, rectified, and compared by a level comparator. If the clamp is not closed properly, an "open jaw" annunciator appears on the LCD.

### A thorough grounding in grounding

If grounds are not properly established, all kinds of undesirable things can happen. Electrical systems can become hazardous, electronics systems can become noisy, large spikes on the power line can damage or destroy electronics products. For these reasons, every consumer electronics service technician should be aware of the importance of grounds, and the methods for measuring their effectiveness, even if it's not one of the things they do on a daily basis. ■

*News* (from page 5)

the DTV transition will be of great financial benefit to Acrodyne and Sinclair." CEA also rejected calls for the FCC to impose DTV receiver standards or require DTV reception capability in all television receivers. "A thorough review of the existing statutes clearly indicates that the FCC lacks the authority to mandate receiver performance standards," said Shapiro. "The FCC itself has consistently echoed this belief as well. The Commission has wisely recognized that manufacturers will be driven by market-forces to make available to consumers digital receivers that receive both NTSC and digital signals correctly refusing to 'preclude equipment manufacturers from designing digital receivers that do not receive NTSC signals.' We urge the Commission to retain this position."

### CEA and SAE to Develop IDB Standards

The Consumer Electronics Association (CEA) and the Society of Automotive Engineers International (SAE) have finalized an agreement to develop vehicle standards for the Intelligent Transportation System Data Bus (IDB). The agreement formalizes a working relationship between industry organizations to standardize the way consumer electronics products connect and communicate in automobiles.

"CEA is pleased to contribute the experience gained from more than 75 years of setting consumer electronics standards to this historic collaboration," said Gary Shapiro, CEA president and CEO. "Standardizing the way mobile electronics products communicate will allow the automotive and consumer electronics industries to offer consumers the latest technologies in their cars. The relationship outlined in this agreement will create new profit opportunities for these industries in adding value to consumer products."

Under the terms of the agreement, the parties will form a steering committee to establish goals for the development of standards and assign responsibilities to each of the organizations. The committee also will provide a forum to exchange information, relay information on industry and organization needs, and resolve any differences that surface in the process. "We look forward to working with SAE and other organizations and groups to get the standards written. As this technology begins to come to market, it is important for the standards development organizations like CEA and SAE to work in partnership to build strong consensus in the industry," said Shapiro.

IDB is a serial communication bus that supports an open, non-proprietary standard architecture to allow multiple electronic devices to be installed easily, cost-effectively and safely in any vehicle. New IDB devices plug-and-play, letting car owners rely on a pre-configured bus, ready to accommodate compliant devices. These standards will promote consistent installation, minimizing the need for device or vehicle-specific customizing. There is no complicated wiring and no intensive installation time is needed.

SAE performs a role as a global leader in Intelligent Vehicles (IV) and IDB technology. The SAE IDB Committee developed the architecture and the IDB protocol specifications with the input of automakers, automotive suppliers, electronics companies, consulting firms, and research companies. The IDB and some of its applications were first displayed at Convergence '98. In October, 2000, SAE will return to Convergence with the latest developments in IV and IDB. SAE is administering the National Intelligent Vehicle Initiative Meeting being held in Washington, DC on July 19-20 by the Department of Transportation and will hold its own IV Congress in Fall, 2001.

SAE is a non-profit educational and scientific organization dedicated to advancing mobility technology to better serve humanity. More than 70,000 engineers and scientists, who are SAE members, develop technical information on all forms of self-propelled vehicles including automobiles, trucks and buses, off-highway equipment, aircraft, aerospace vehicles, marine, rail, and transit systems. SAE disseminates this information through its meetings, books, technical papers, magazines, standards, reports, professional development programs, and electronic databases.

### CEA published mobile electronics standards

The Consumer Electronics Association (CEA) published two standards outlining specifications for mobile electronics products. EIA/CEA-827 defines the method for measuring the sound level of a vehicle security-sounding device. EIA-803 specifies the terms, abbreviations and definitions used in the sale and installation of aftermarket mobile electronics products.

"These standards will improve consumers' ability to compare products and will ease purchasing by ensuring consistent labeling and measurement of mobile electronics products," said Ralph Justus, CEA vide president of Technology and Standards. "Consumers, salespeople and professional installers can now select and install products based on a standard set of terms."

EIA/CEA-827 specifies the exact distance (1 meter) and conditions under which the volume of mobile security system sounding devices must be tested. The standard applies to electronic sirens, mechanical sirens, diaphragm horns, electronics speakers and electromechanical horns. "For the first time, consumers will have comparison information in determining sound levels when purchasing vehicle alarm systems," remarked Mark Gottlieb, executive vide president, DesignTech International. "Consumers will no longer have to rely on arbitrary decibel level ratings based on non-standardized test." In addition to the distance from the measuring device, the standard specifies the distance from sound reflective surfaces, test site background noise and the construction of the testing jig.

EIA-803 defines the wiring terms, abbreviations, and definitions used in aftermarket mobile audio and security products. The standard can be applied to product packages, installation manuals, wiring diagrams, and wire leads of mobile electronics products. "Standardized audio and vehicle security systems terminology improves the continuity of installation information," explained High Whitemen, president, Quality Auto Sound, Inc. and Chairman of CEA's Mobile Electronics Certified Professional (MECP) program. "These standards improve the level of professionalism in the mobile installation industry by providing installers with a universal coding system for planning and installing automotive electronics products." ■

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- Only individual readers may use Readers' Exchange, and items must be restricted to those that are ordinarily associated with consumer electronics as a business or hobby. If you're in business to sell the item(s) you want to offer for sale, the appropriate place for your message is in a paid advertisement, not Readers' Exchange.
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- All submissions must be typed or printed clearly!

**Send your Readers' Exchange submissions to:**
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Sencore SC3100, scope, meter, frequency counter, $1995.00. Sencore PRS570, digital AC isolation transformer, $595.00. Many other pieces of test equipment priced to sell. E-mail: sdcal@worldnet.att.net for complete list and prices. *Contact: Alex, 858-274-6935 (work) 9 a.m- 5 p.m.*

B&K 545 auto component analyzer, $1500.00. *Contact: Kim Gutzke, 612-869-4963.*

Sams #101-1862. Best offer will transport within 300 miles. *Contact: Ben, 804-526-6412.*

Radios, test equipment, radio tubes and literature. Send $0.99 SASE. *Contact: Paul Williams, 236A Beaver Valley Pike, New Providence, PA 17560-9622, phone: 717-786-3803.*

## WANTED

Hi-fi tube equipment, pro-sound gear, limiters, Technics SP-10MK2 and MK3 turntables with obsidium base. *Contact: Kim Gutzke, 612-869-4963.*

Umax UC-630 scanner service manual/schematics/repair manual/operator's manual/setup. Will buy or pay copy costs. *Contact: L. Hicks, 1218 S. 257th Place, Des Moines, WA 98198.*

IC Part # DEC0015B. Also service manual for Emerson VCR953. Will buy or copy. *Contact: Murray Goldstein, 1622 Granfern Avenue, West Palm Beach, FL 33415, phone: 561-966-8862.*

Zenith 9-351 deflection module, used. *Contact: Ray's TV, Box 70, Lacombe, LA 70445, E-mail: wwwray@webtv.net.*

SAE Model #P101 pre-amp or part #11-0224 (ICU210). SAE Model T101 stereo receiver or part # Fd 612U14 (tuner unit). *Contact: Just Electronics, 316 North Lake Street, Mundelein, IL 60060, phone: 847-949-8808.*

Output transformer for Crosley radio model 12A. Must be original. *Contact: Paul Williams, 236A Beaver Valley Pike, New Providence, PA 17560-9622, phone: 717-786-3803.*

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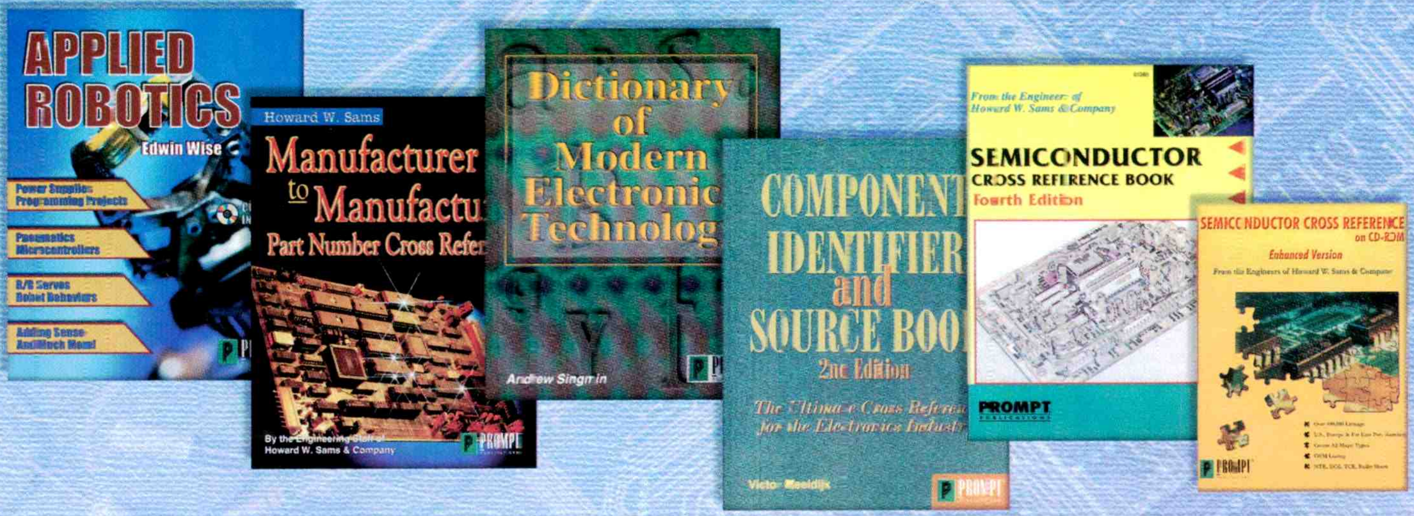


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