THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

November 1999

Microwave oven servicing

Plasma TV

Servicing RCA's CTC166 ... TC167 ... e circuits

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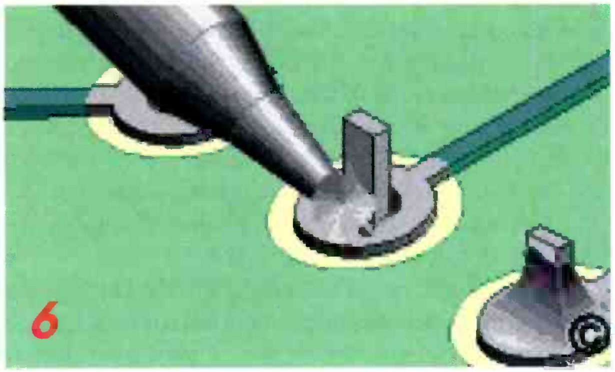

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ON THE COVER

Once the technician has made the necessary repairs to restore the television set to operation, it's important to check all the functions, and make any adjustments necessary to make sure the picture is as sharp and clear as it can be before returning the product to the owner. (Photo courtesy B&K Precision)

Editorial

by Nils Conrad Persson

Some of the new technology

At the Consumer Electronics Show (CES) in Las Vegas, Nevada, in January, a number of consumer electronics manufacturers showed plasma display screens. To highlight the quality of the picture on these screens, the displays used some kind of high-definition source. The result was spectacular: brilliant colors, fine detail, perfect focus.

Of course, the program material was selected to enhance the effect of the displays: intense colors, interesting shapes, and textures. But viewers couldn't help but be incredibly impressed by this new display technology.

As with everything else in this world, there are several downsides to plasma display. First of all, it is prohibitively expensive. The sets being shown would retail for somewhere in the range of $7,000. Then there's the life expectancy. Because of the current state of the technology, while these displays have a fairly long life, that life is limited.

There are a few other disadvantages to plasma displays. The black that they render is not as black as the black that can be produced by a CRT. Plasma displays are subject to a phenomenon called "motion disturbance." This can be best described as what appears to be a trailing edge following an object in motion. Plasma displays are subject to afterimages: that is, if the viewer is not careful and leaves a still image on the screen, it will "burn in." Plasma displays require high currents to operate. And finally, changes in barometric pressure can cause changes in the contour of the screen's large surface.

But there are a few big pluses for the plasma screens. Not only do they produce a beautiful picture, but they are, compared to CRTs, thin. They don't have that long neck in the back necessary in a CRT to provide the required distance from electron gun to screen. That means that plasma displays take up less space in relation to the surface area of the screen. And it means, of course, that a plasma display can actually be attached to a wall or a ceiling, just the way we've seen it in the commercials, with the rest of the set tucked away somewhere unobtrusively.

Something else that makes plasma displays different from CRTs is the difference in nature between the two types of display. In the CRT, the picture is produced by a single set of electron beams that scan the entire surface of the display, each picking out the color areas assigned to it, modulated by the luminance information, and thus producing a picture. In a plasma display, each pixel is individually addressed and stimulated to produce its portion of the picture. This makes a plasma display a more complicated device.

But one of the things that makes plasma displays so exciting is that for the first time, there is actually an alternative to the CRT for creating pictures for TV or computers. Well, sure, there are LCD screens, projection screens (both front and rear projection) and such things as DiamondVision for sporting events (which I must confess, I have no idea how it operates). But LCDs are only suitable for small displays, projection screens in fact use CRTs (one for each color), and DiamondVision, or similar displays, seem to be suited for extremely large displays.

The article "Plasma TV," in this issue provides a little detail on the technology of the plasma display system. There will be more in future issues. If any readers should encounter some of these new components, we here at **ES&T** would love to hear about their experiences with it.

Antennas for DTV

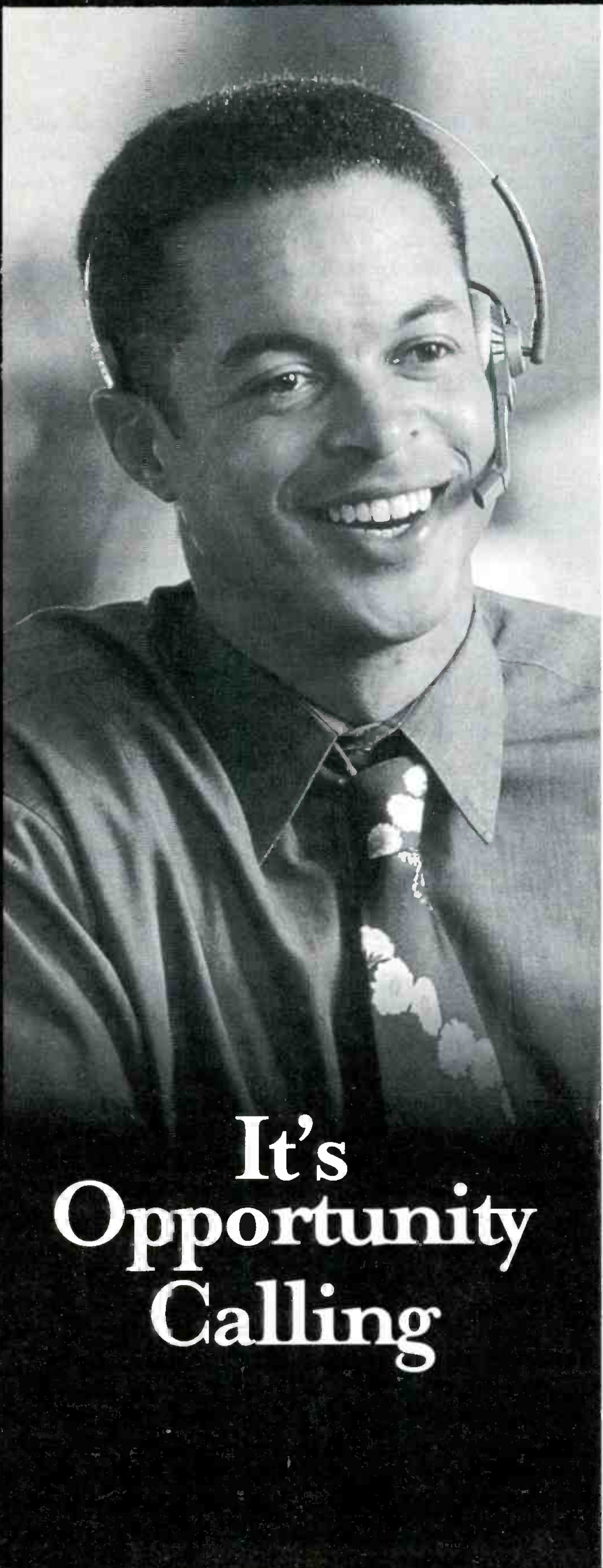
Digital television, in the form of terrestrial HDTV is here and growing. And it's not being carried by cable systems. At least not yet. Viewers who are watching HDTV are getting the signal over the air via antennas. The folks who sell the television sets that viewers are using to watch the new HDTV programming are not leaving it up to chance whether or not the antennas that are being used to receive the signal are the right type for the set of conditions that exists at the viewer's location. They want to make sure that the viewers are satisfied with the pictures they see on those expensive new sets.

Moreover, for a number of reasons, it's in the best interests of the antenna manufacturers to help both the consumer and the retailer to select the right antenna for the particular location. Think of it this way: if the consumer buys a very high priced HDTV set and doesn't get good reception, he's going to be unhappy with the set manufacturer, the dealer, the antenna manufacturer. And he might want to exchange his antenna, and have the dealer install a new one. No antenna installer wants to go back and do the same installation over again.

So the set manufacturers and the antenna manufacturers, under the aegis of the Consumer Electronics Manufacturers Association (CEMA), have generated information that facilitates selection of the right antenna for HDTV. In just about every TV viewing area in the United States, engineers have mapped signal strengths throughout the area and developed color-coded maps that show the signal strength available, and the type of antenna that will be needed to capture a usable HDTV signal.

The article "Antennas for DTV" in this issue provides details of this program. This is the first time that the general public had such carefully detailed maps that relate to TV reception. The map system was based on extensive lab and field testing, correlating antenna performance with reception environments, and numerous conservative assumptions about home set-up.

In consumer electronics, the beat goes on, and the quality of audio and video entertainment in the home just keeps getting better and better.



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News

CEMA finalizes indoor antenna specifications

The Consumer Electronics Manufacturers Association (CEMA) has announced another significant milestone in the industry's TV Antenna Selector Map Program. The program, that makes antenna sales easy for consumers by using color-coded maps that match outdoor antenna performance, has recently implemented a certification program for indoor antennas that comply with stringent technical specifications to ensure maximum performance. Outdoor antenna performance specifications were completed last year, corresponding to the color labels on product packaging that makes proper product selection a snap for consumers. The specifications for both types of antennas are contained in EIA standards, which are available for use by any antenna manufacturer.

Ray Conover of Conus Communications and chair of the CEMA R-5 (antenna engineering) Committee, stated, "This is another industry milestone because once again the antenna industry has worked together to create standards that will give consumers the information they need when determining what antenna to buy. They can be assured that if their antenna contains the CEMA indoor or outdoor mark, that product complies with strict standards on manufacturing and labeling."

The voluntary standards were prepared by the R-5 Committee to provide manufacturers of television receive antennas with appropriate guidance on determining antenna categories and minimum performance requirements to comply with the CEMA program. Essential elements of this program includes the color coding of various television reception environments in a market, and corresponding color-coded labels on antenna packaging.

The standards serve as a guide to manufacturers for categorizing both indoor (Engineering Bulletin EIA/CEB-7) and outdoor (Engineering Bulletin EIA/CEB-6-C) antennas. They discuss antenna types and characteristics, packaging and marking specifications, as well as provide minimum performance requirements. CEMA's R-5 Committee also developed EIA-774 for manufacturers, a document which standardizes all antenna test and measurement procedures.

Outdoor antennas that meet or exceed these criteria are allowed to carry the outdoor antenna mark, which corresponds to the color coded maps and have been available to retailers since early this year. Indoor antennas, which do not correspond to the maps because of the multiple factors in determining good reception in a specific location, are CEMA-certified as meeting or exceeding minimum industry-wide performance requirements. CEMA antenna manufacturers are already using the mark on outdoor product, and will begin displaying the indoor mark at the retail level starting May 1, 2000. Over the next few months, manufacturers not yet in compliance will make improvements to indoor products to meet the CEMA certification.

The mapping program has expanded the number of U.S. maps to 272. Conover explains, "For technical reasons based on the location of transmit towers, we have created separate maps for adjacent, 'sister' markets in some areas, so some areas might have two maps to cover a city — now we have 272 maps representing 197 markets. All but about 20 of the smallest markets have been mapped, and to date, over 70 percent of the map kits are available for order. We expect all market map kits to be finished, printed, and ready for distribution by the end of the summer."

Neil Terk, president of Terk Technologies and chair of CEMA's Antenna Subdivision, commented, "So far we have had over 400 retailers and installers even overseas order map kits. Antenna manufacturers, retailers, and consumers are all benefiting from this program which provides retailers with the tools they need to increase antenna sales and consumers with the tools they need to make the right purchasing decision." Terk continued, "As consumers continue to embrace digital satellite TV systems, and as they are becoming more excited about high definition television, they are looking for today's antennas to provide them with that digital link — the reception of local off-air signals. The initial results of the CEMA map program have been phenomenal and we expect it to grow given the cost-effective, space-saving technology solution that antennas offer."

Those wishing to receive a copy of any EIA standard may refer to the CEMA website at <www.CEMAcity.org/works/engineering/standards>, or call Global Engineering Documents at (800) 854-7179. Map kits may be ordered for a nominal charge from: The CEMA Antenna Selector Map Program, c/o Dan Dolan Printing, 2301 E. Hennepin Street, Minneapolis, MN, 55413, fax: (612) 676-0080.

CEMA applauds DTV programming deal

Gary Shapiro, president of the Consumer Electronics Manufacturers Association (CEMA), recently released the following statement: "Mitsubishi's announcement that it will underwrite the conversion of CBS' prime time line-up to HDTV is great news for the industry and consumers. DTV products are widely available and more than 50 broadcasters have started digital transmissions. At this stage, quality HDTV content is critical to the digital transition — it's going to drive the next stage of the evolution."

"Consumers are 'wowed' by the technology and nearly 26,000 consumers have bought a DTV. But all of our research tells us that their purchase decisions are driven largely by content. Our industries must work together to ensure that DTV consumers have something to see."

"The partnership between Mitsubishi and CBS represents the kind of inter-industry cooperation that is critical to the success of DTV. To foster this cooperation, CEMA has scheduled a DTV Summit in Los Angeles to address the issues surrounding DTV content and ensure a broad range of HDTV program options for consumers." ■

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Soldering and desoldering update and PC boards/parts handling

by the ES&T Staff

Soldering is the process of joining two metals by the use of a solder alloy, and it is one of the oldest known joining techniques. Faulty solder joints remain one of the major causes of electronics equipment failure and thus the importance of high standards of workmanship in soldering cannot be overemphasized.

While much of the following material may seem very basic, it never hurts to review the fundamentals of a procedure as important as soldering. Moreover, some products and processes have changed and evolved, and are worthy of mention.

Properties of solder

Solder used for electronics is a metal alloy, made by combining tin and lead in different proportions. You can usually find these proportions marked on the various types of solder available.

With most tin/lead solder combinations, melting does not take place all at once. Fifty-fifty solder begins to melt at 183°C (361°F), but it's not fully melted until the temperature reaches 216°C (420°F). Between these two temperatures, the solder exists in a plastic or semiliquid state.

The plastic range of a solder varies, depending upon the ratio of tin to lead. With 60/40 solder, the range is much smaller than it is for 50/50 solder. The 63/37 ratio, known as eutectic solder, has practically no plastic range, and melts almost instantly at 183°C (361°F).

The solders most commonly used for hand soldering in electronics are the 60/40 type and the 63/37 type. Due to the plastic range of the 60/40 type, you need to be careful not to move any elements of the joint during the cool down period. Movement may cause what is known as disturbed joint. A disturbed joint has a rough, irregular appearance and looks dull instead of bright and shiny. A disturbed solder joint may be unreliable and may require rework.

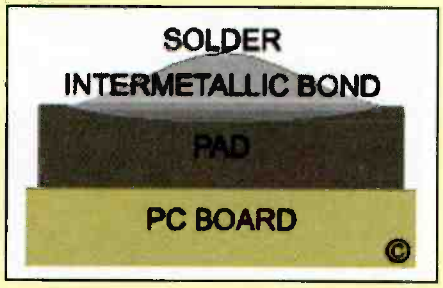


Figure 1. Wetting occurs when molten solder penetrates a copper surface, forming an intermetallic bond.

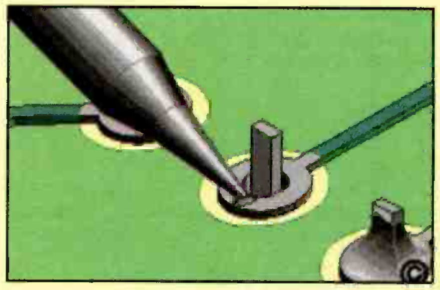


Figure 2. Insufficient thermal linkage will occur when there is insufficient solder between the pad and soldering iron tip.

Wetting action

When the hot solder comes in contact with a copper surface, a metal solvent action takes place. The solder dissolves and penetrates the copper surface. The molecules of solder and copper blend to form a new alloy, one that's part copper and part solder. This solvent action is called "wetting" and forms the intermetallic bond between the parts (Figure 1). Wetting can only occur if the surface of the copper is free of contamination and from the oxide film that forms when the metal is exposed to air. Also, the solder and work surface need to have reached the proper temperature.

Although the surfaces to be soldered may look clean, there is always a thin film of oxide covering it. For a good solder bond, surface oxides must be removed during the soldering process using flux.

Flux

Reliable solder connections can only be accomplished with truly cleaned surfaces. Solvents can be used to clean the surfaces prior to soldering but are insufficient due to the extremely rapid rate at which oxides form on the surface of heated metals. To overcome this oxide film, it is necessary in electronic soldering to use materials called fluxes. Fluxes consist of natural or synthetic rosins and sometimes chemical additives called activators.

It is the function of the flux to remove oxides and keep them removed during the soldering operation. This is accomplished by the flux action which is very corrosive at solder melt temperatures and accounts for flux's ability to rapidly remove metal oxides. In its unheated state, however, rosin flux is non-corrosive and non-conductive and thus will not affect the circuitry. It is the fluxing action of removing oxides and carrying them away, as well as preventing the reformation of new oxides, that allows the solder to form the desired intermetallic bond.

Flux must melt at a temperature lower than solder so that it can do its job before the soldering action takes place. Flux will volatilize very rapidly; thus it is mandatory that flux be melted to flow onto the work surface and not be simply volatilized by the hot iron tip to provide the full benefit of the fluxing action. There are varieties of fluxes available for many purposes and applications. The

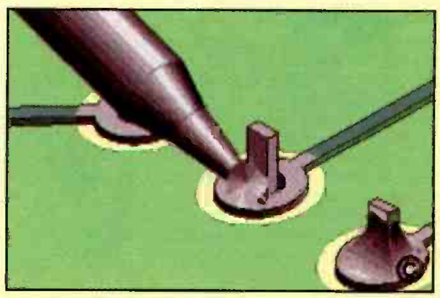


Figure 3. A solder bridge provides thermal linkage to transfer heat into the pad and component lead.

Adapted with permission from the manual "Rework of electronic assemblies," at the Circuit Technology Center web site (http://www.circuitnet.com). The company's addresses are: 45 Research Drive, Haverhill, MA 01832-1293, Phone: 978-374-5000, Fax: 978-372-5700; 5045 Brandin Court, Fremont, CA 94538-3140, Phone: 510-490-6800, Fax: 510-490-5505.

most common types include: Rosin — No Clean, Rosin — Mildly Activated, and Water Soluble.

When used, liquid flux should be applied in a thin, even coat to those surfaces being joined before the heat is applied. Cored wire solder and solder paste should be placed in such a position that the flux can flow and cover the joints as the solder melts. Flux should be applied so that no damage will occur to the surrounding parts and materials.

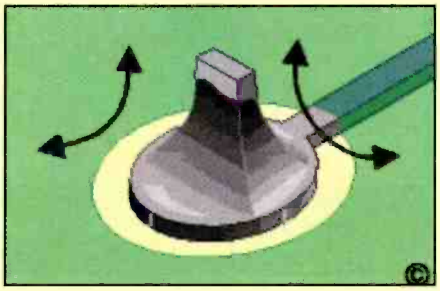


Figure 4. Solder blends to the soldered surface, forming a small contact angle.

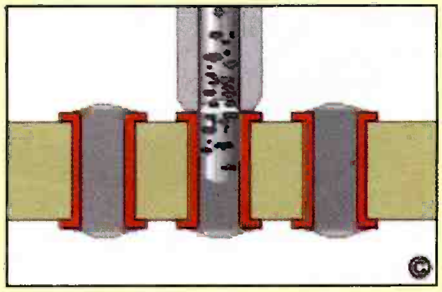


Figure 5. Removing excess solder from plated holes using a vacuum desoldering tool.

Soldering irons

Soldering irons come in a variety of sizes and shapes. A continuously tinned surface must be maintained on the soldering iron tip's working surface to ensure proper heat transfer and to avoid transfer of impurities to the solder connection.

Before using the soldering iron, the tip should be cleaned by wiping it on a wet sponge. When not in use, the iron should be kept in a holder, with its tip clean and coated with a small amount of solder

Note

Although tip temperature is not the key element in soldering, always start at the lowest temperature possible. A good rule of thumb is to set the soldering iron tip temperature at 260°C (500°F) and increase the temperature as needed to obtain the desired result.

Controlling heat

Controlling soldering iron tip temperature is not the key element in soldering. The key element is controlling the heat cycle of the work. How fast the work gets hot, how hot it gets, and how long it stays hot are the elements to control for reliable solder connections.

Thermal mass

The first factor that needs to be considered when soldering is the relative thermal mass of the joint to be soldered. This mass may vary over a wide range. Each joint has its own particular thermal mass and how this combined mass compares with the mass of the iron tip determines the time and temperature rise of the work.

Surface condition

A second factor of importance when soldering is the surface condition. If there are any oxides or other contaminants covering the pads or leads, there will be a barrier to the flow of heat. Even though the iron tip is the right size and temperature, it may not be able to supply enough heat to the joint to melt the solder.

Thermal linkage

A third factor to consider is thermal linkage. This is the area of contact between the iron tip and the work.

Figure 2 shows a view of a soldering iron tip soldering a component lead. Heat is transferred through the small contact area between the soldering iron tip and pad. The thermal linkage area is small.

Figure 3 also shows a view of a soldering iron tip soldering a component lead. In this case, the contact area is greatly increased by having a small amount of solder at the point of contact. The tip is also in contact with both the pad and component, further improving the thermal linkage. This solder bridge provides thermal linkage and assures the rapid transfer of heat into the work.

Applying solder

In general, the soldering iron tip should be applied to the maximum mass point of the joint. This will permit the rapid increase in temperature of the parts to be soldered. Molten solder always flows from the cooler area toward the hotter one.

Before solder is applied, the surface temperature of the parts being soldered must be increased above the solder melting point. Never melt the solder against the iron tip and allow it to flow onto a surface cooler than the solder melting temperature. Solder applied to a cleaned, fluxed and properly heated surface will melt and flow without direct contact with the heat source and provide a smooth, even surface, filleting out to a thin edge. Improper soldering will exhibit a built-up, irregular appearance and poor filleting. For good solder joint strength, parts being soldered must be held in place until the solder solidifies.

If possible, apply the solder to the upper portion of the joint so that the work surfaces and not the iron will melt the solder, and so that gravity will aid the solder flow. Selecting cored solder of the proper diameter will aid in controlling the amount of solder being applied to the joint. Use a small gauge for a small joint, and a large gauge for a large joint.

Post solder cleaning

When cleaning is required, flux residue should be removed as soon as possible, but no later than one hour after soldering. Some fluxes may require more immediate action to facilitate adequate removal. Mechanical means, such as agitation, spraying, brushing, and other methods of applications, may be used in conjunction with the cleaning solution.

The cleaning solvents, solutions, and methods used should not have any affect on the parts, connections, and materials being cleaned. After cleaning, boards should be adequately dried.

Resoldering

Care should be taken to avoid the need for resoldering. When resoldering is required, quality standards for the resoldered connection should be the same as for the original connection.

A cold or disturbed solder joint will usually require only reheating and reflowing of the solder with the addition of suitable flux. If reheating does not correct the condition, the solder should be removed and the joint resoldered.

Workmanship

Solder joints should have a smooth appearance. A satin luster is permissible. The joints should be free from scratches,

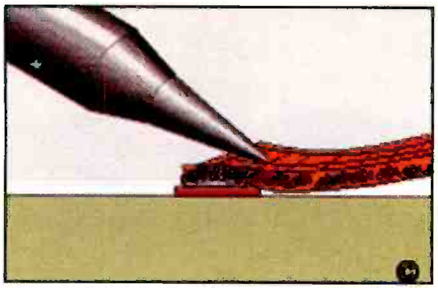


Figure 6. Removing excess solder from surface mount pads using a solder iron and solder braid.

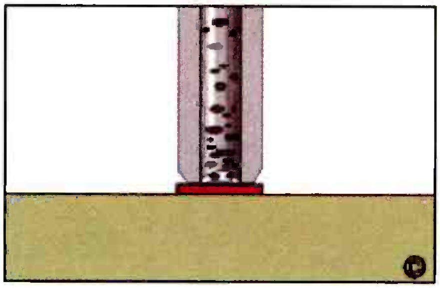


Figure 7. Removing excess solder from surface mount pads using vacuum desoldering.

sharp edges, grittiness, looseness, blistering, or other evidence of poor workmanship. Probe marks from test pins are acceptable providing that they do not affect the integrity of the solder joint.

An acceptable solder connection should indicate evidence of wetting and adherence when the solder blends to the soldered surface. The solder should form a small contact angle; this indicates the presence of a metallurgical bond and proper metallic continuity from solder to surface (Figure 4).

Smooth clean voids or unevenness on the surface of the solder fillet or coating are acceptable. A smooth transition from pad to component lead should be evident.

The following information describes the recommended method of preparation for soldering and component removal.

Caution

Silicone based lubricants or hand creams should not be used on or near surfaces that are to be soldered.

Soldering iron tip selection

The size and shape of the soldering iron tip will have an effect on the rate of heat transfer. Larger tips with more surface area will transfer heat faster than smaller tips.

Tip size is based on the size of the component. While there is no exact rule about how the size of a soldering iron tip should compare to the size of the termination, if the tip extends too far beyond the edges of the joint, it could come in contact with another component or the surface of the board. Where possible, the width of the soldering iron tip should be slightly smaller than the width of the pad.

Component removal tip selection

The size and shape of the component removal tip will have an effect on the rate of heat transfer. Larger tips with more surface area will transfer heat faster than smaller tips.

1. Vacuum desoldering tip selection: The smallest tip should be selected providing that the tip fits over the component lead and allows room for molten solder and air to pass through it. The outside diameter of the tip should not cover the pad completely or touch the PC board base material or solder mask. If the tip extends too far beyond the edges of the joint, it could come in contact with another component or the surface of the PC board.

2. Hot air tool tip selection: The smallest tip should be selected providing that the proper air flow is delivered to the leads and solder joints. If the tip is too large, it may extend beyond the edges of the component and cause reflow to adjacent components or burn the surface of the PC board.

3. Conductive tool tip selection: The smallest tip should be selected providing that the tip fits over the entire component and contacts all the leads evenly. If the tip is too large, it may extend beyond the edges of the component and contact another component or the surface of the PC board.

General preparation

1. If needed, PC boards should be cleaned prior to soldering and component removal operations. Oxidation and contamination should be removed by methods that do not damage leads or parts, and do not cause contamination or hinder solder wetting.

2. If required, PC boards should be baked in a suitable oven to remove any absorbed moisture. Time between bake and soldering should not exceed 5 days, depending on atmosphere humidity levels. Temperature and time of baking is to be determined on an individual basis.

3. If needed, tin component leads prior to soldering.

4. If needed, reform component leads or replace the component if the leads do not meet the specification required.

Preparation — excess solder

Before inserting a component into a plated through hole for through hole soldering, or onto pads for surface mount soldering, it may be necessary to remove any excess solder. This is recommended for two main reasons:

1. If a component was previously soldered at the rework location, some of the original solder will remain attached to the pad. That solder has already been heated twice. If it becomes part of the new solder joint, it will have been heated at least three or even four times. Reheating solder three or four times, even with the addition of flux, may affect the physical composition of the metals. Every time that solder is reheated, the molecular structure tends to become increasingly brittle.

Solder needs to remain ductile in order to absorb the stresses of expansion and contraction caused by heating and cooling. Old solder should be removed and replaced with new solder whenever a component is reattached.

2. Excess solder in a plated through hole or excess solder on surface mount pads may interfere with the proper placement of the new component.

Plated-through-hole preparation, vacuum desolder tool method

Solder removal by wicking is not recommended for removal of solder from a plated through hole. A powered vacuum desoldering tool is recommended.

The powered vacuum desoldering tool has a heated tip with a hole in the center to vacuum melted solder away. There are different tip sizes depending on the size of the job. The diameter of the tip should match the width of the pad. A larger tip will extend over the edge of the pad and could potentially burn the board.

1. If needed, clean the area.

2. Inspect the hole. If there is not sufficient solder covering the pad to provide for proper heat transfer, the hole should be filled with solder. Filling the hole improves the thermal linkage between the desolder tool tip and the solder in the hole. This ensures a rapid melt and reduces potential for pad or hole damage.

3. Place the heated desoldering tip onto the pad until you feel the solder melt. Do not apply any downward or sideways pressure on the pad.

4. After the solder melts, activate the vacuum and suck the solder through the hole in the tip into the solder storage chamber (Figure 5).

It should only take a few seconds for all of the solder to be removed. After the solder is vacuumed from the hole, lift the tool. Continue the vacuum for an additional few seconds to make sure that the solder has had enough time to travel through the tip into the storage chamber.

5. If needed, remove solder from the remaining holes so that the component can be inserted without force.

6. Clean the area.

Surface mount pad preparation, solder braid method

Solder braid is made from stranded copper with a powdered flux inside the copper strands. Solder braid will absorb the solder when heat is applied to the braid and solder surface.

1. Solder braid comes in different widths. Select a size that matches the width of the pad, or just slightly smaller, where possible.

Note: Most solder removal braid comes with a powdered flux inside the copper strands. Adding additional flux will help to transfer the heat faster and helps to improve the wicking or capillary action of the copper braid.

2. Select a soldering iron tip to match the width of the pad. It the tip is too large for the braid, it will hang over the edges and could burn the board or the solder mask. If the tip is too small, it will take much longer to heat up the braid.

3. Add a small amount of liquid flux to the braid.

4. Place braid over the pad and rest the iron tip on the braid. (Figure 6). As you apply the heat, it's important to avoid putting any downward or sideways pressure on the pad, since the adhesive resin underneath the pad is being heated at the same time. Adhesion between the PC

Circle (70) on Reply Card

Test Your Electronics Knowledge

by J.A. Sam Wilson

1. One horsepower = _______________ watts.

2. In a transistor amplifier, the emitter resistor is used
A. To provide dc bias for the base.
B. To provide temperature stabilization.

3. Name four types of coupling between amplifiers.

4. What is the next binary number after 101010?

5. Is the following statement correct?
Anything you do to increase the gain of an amplifier will automatically decrease its bandwidth.
A. Correct
B. Incorrect

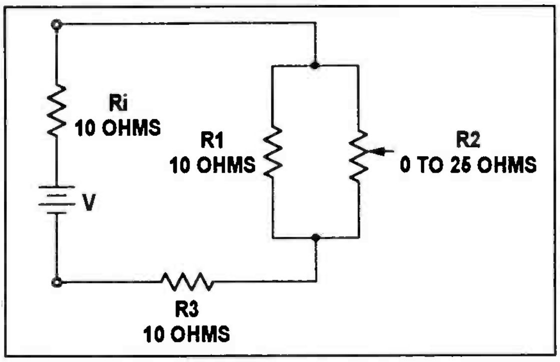
6. Name six types of receivers in any order.

7. For better fidelity, the if transformers in a superheterodyne receiver should be slightly
A. Overcoupled.
B. Undercoupled.

8. Three kinds of losses in power transformers are:

9. Comparing choke and capacitive inputs for power supply filters, which provides the higher output voltage?
A. Choke
B. Capacitive

10. The maximum output power for the battery in Figure 1 occurs when R2 = __________ (Ω) ohms.



Answers to test

1. One horsepower = 746 watts.
2. B
3. Transformer, RC, Direct, Impedance
4. 101011
5. A
6. Crystal (or crystal input), Regenerative, Superregenerative, TRF, Superheterodyne, Reflex
7. A
8. Hysteresis, Copper, Eddy Current
9. B
10. 0Ω

"The powered vacuum desoldering tool has a heated tip with a hole in the center to vacuum melted solder away."

board and the pad is at its weakest when heated. Sideways pressure against the pad can lift the pad off the PC board surface.

The weight of the soldering iron should apply sufficient contact to quickly heat the solder braid. The heat that passes through the braid should melt any solder that remains on the pad within a few seconds.

The wicking action of the copper will draw the solder away from the pad. This wicking action should be visible. When the wicking action stops, remove the braid and the iron. The used portion of the braid should be clipped off and any other pads should be prepared exactly like the first.

Surface mount pad preparation, vacuum desolder tool method

The powered vacuum desoldering tool has a heated tip with a hole in the center to vacuum melted solder away. There are different tip sizes depending on the size of the job. The diameter of the tip should match the width of the pad. A larger tip will extend over the edge of the pad and could potentially burn the board.

1. Apply a small amount of liquid flux to the pad.

2. Place the heated tip onto the pad until you feel the solder melt. Do not apply any downward or sideways pressure on the pad, the weight of the handpiece tip is sufficient.

Caution: Avoid exerting any pressure on the pad.

3. After the solder melts, activate the vacuum and suck the solder through the hole in the tip into the solder storage chamber (Figure 7).

It should only take a few seconds for all of the solder to be removed. After the solder is vacuumed from the pad, lift the tool. Continue the vacuum for a few seconds to make sure that the solder has had enough time to travel through the tip into the storage chamber.

4. Any other pads should be prepared exactly like the first.

5. Clean the area. ■

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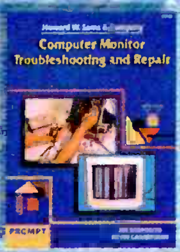

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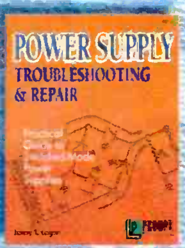

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Microwave oven servicing

by John C. Gallawa

Microwave ovens have added a measure of speed and convenience to cooking and heating foods that fits in nicely with the busy lifestyles of people of today. With the push of a few buttons, it's possible to cook an entire meal in a fraction of the time it would take in a conventional oven or on the stovetop, or quickly heat a single cupful of water to make a cup of tea or instant coffee. But as with any other appliance or consumer electronics product, microwave ovens do fail.

A competent consumer electronics technician can learn to service microwave ovens, but it's important to take precautions. Microwave ovens are different from most other electronics devices in the home. There are high voltages present, several thousand volts. But unique to microwave ovens is the ability to deliver high current levels at those high voltages. *In other words, a microwave oven is capable of delivering a lethal electrical jolt to anyone working on it who is not aware of the danger, or who gets careless.* If you choose to service microwave ovens, be sure that you are aware of the hazards they present, and always follow correct safety procedures. And *never work alone when you service microwave ovens.*

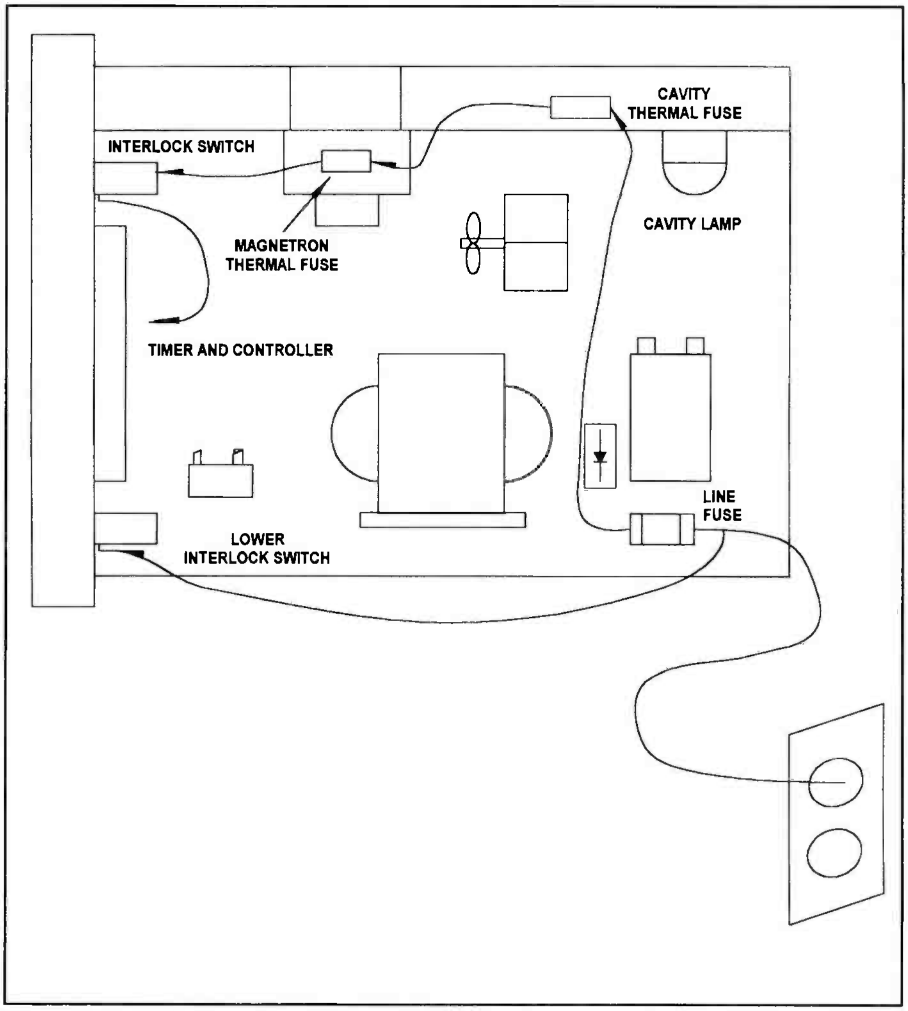

Figure 1. A generalized diagram of power flow into and through a typical microwave oven.

How a microwave oven works

Microwave ovens use various combinations of electrical circuits and mechanical devices to produce and control an output of microwave energy for heating and cooking. Generally speaking, the systems of a microwave oven can be divided into two fundamental sections: the control section and the high-voltage section.

The control section consists of a timer (electronic or electromechanical), a system to control or govern the power output, and various interlock and protection devices. The components in the high-voltage section serve to step up the house voltage to high voltage. The high voltage is then converted microwave energy.

Basically, here is how it works: As shown in Figure 1, electricity from the wall outlet travels through the power cord and enters the microwave oven through a series of fuse and safety protection circuits. These circuits include various fuses and thermal protectors that are designed to deactivate the oven in the event of an electrical short or if an overheating condition occurs.

If all systems are normal, the electricity passes through to the interlock and timer circuits. When then oven door is closed, an electrical path is also established through a series of safety interlock switches. Setting the oven timer and starting a cook operation extends this voltage path to the control circuits.

The control section

Generally, the control system includes either an electromechanical relay or an electronic switch called a triac, as shown in Figure 2. Sensing that all systems are "go," the control circuit generates a signal that causes the relay or triac to activate, thereby producing a voltage path to the high-voltage transformer. By adjusting the on-off ratio of this activation signal, the control system can govern the application of voltage to the high-voltage

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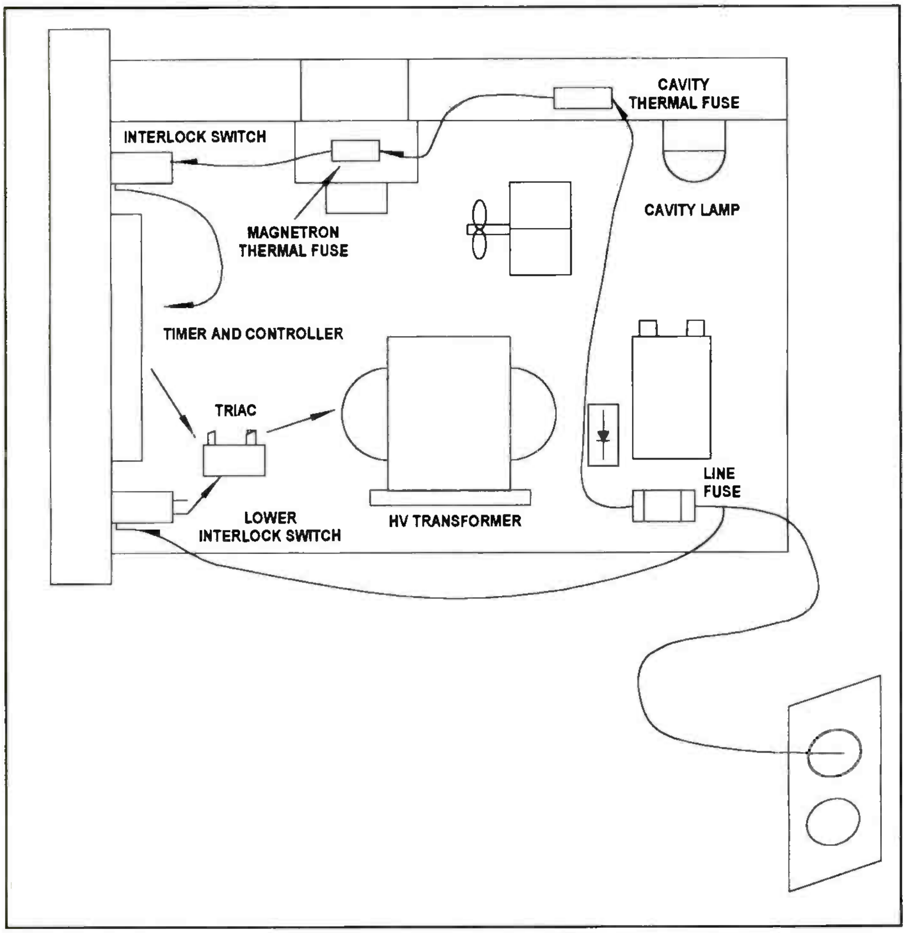


Figure 2. The microwave oven control system includes either an electromechanical relay or an electronic switch called a triac. The control circuit generates a signal that causes the relay or triac to activate, thereby producing a voltage path to the high-voltage transformer. Adjustment of the on-off ratio of this activation signal by the control system governs the application of voltage to the high-voltage transformer, thereby controlling the duty cycle of the magnetron tube.

transformer, thereby controlling the on-off ratio (or duty cycle) of the magnetron tube and therefore the output power of the microwave oven. Some models use a fast-acting power-control relay in the high-voltage circuit to control the output power.

The high voltage section

In the high-voltage section (Figure 3), the high-voltage transformer, along with a special diode and capacitor, arrangement serve to increase the typical household voltage of about 115Vac to approximately 3000Vdc. This high voltage is fed to the magnetron tube, which dynamically converts it to undulating waves of electromagnetic cooking energy.

The microwave energy is transmitted into a metal channel called a waveguide, which feeds the energy into the cooking area where it encounters the slowly revolving metal stirrer blade. Some microwave-oven models use a type of rotating antenna, while others rotate the food through the waves of energy on a revolving carousel. In any case, the effect is to evenly disperse the microwave energy throughout all areas of the cooking compartment. Some waves go directly toward the food, others bounce off the metal walls and flooring and, thanks to special metal screen, microwaves also reflect off the door. So, the microwave energy reaches all surfaces of the food from every direction.

All microwave energy remains inside the cooking cavity. When the door is opened, or the timer reaches zero, the microwave energy stops.

Important microwave oven safety information and procedures

At the risk of repetition, it should be said again, *the microwave oven is a very dan-*

gerous appliance to work on. For your personal safety, we respectfully ask that you read, fully understand, and be prepared to follow carefully all recommended safety precautions, as well as the disclaimer at the bottom of this page *before* proceeding with any tests or troubleshooting.

The high-voltage potential combined with the high-current capability of an operating microwave oven pose a deadly threat to the careless worker. In addition, microwave ovens are radiation-emitting devices. Normally, this does not present a problem. However, improper replacement methods or tampering with safety systems could expose the unwary troubleshooter to dangerous levels of microwave leakage. Therefore, extreme caution and proper procedures *must* be used at all times.

When diagnosing a microwave oven, many problems can be detected merely with careful observation. Most tests can be accomplished with the power off and the oven unplugged. Nonetheless, certain safety habits must be developed and maintained. If you have experience in troubleshooting electrical equipment, some of these safety precautions may be familiar. However, the high-current potential of the high-voltage circuits in a microwave oven make them essentially life-saving steps.

First and always, before attempting any repairs, make certain that the unit is not plugged in.

Before touching any components or wiring, *always discharge the high voltage capacitor*! (See the appropriate section in this article for instructions on discharging this capacitor.) The high voltage capacitor will quite normally maintain a painfully high-voltage charge even after the oven is unplugged. Some capacitors employ a bleeder resistor (either externally or internally) that allows the charge to slowly bleed (or drain) off after the oven is unplugged. Do not trust a bleeder resistor; it may be open. If you forget to discharge the capacitor, your fingers may ultimately provide the discharge path. You only make this mistake a few times, because, while the electric shock is painful, the real punishment comes when you reflexively yank out your hand leaving behind layers of skin on sharp edges that are there as a stinging reminder to never again forget to discharge the high voltage capacitor.

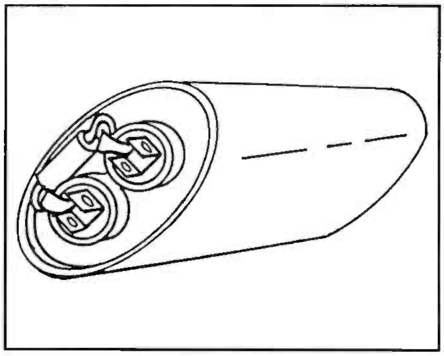


Figure 4. A typical high-voltage capacitor used in microwave ovens.

Never, under any circumstances, touch any oven components or wiring with your hand or even with an insulated tool during a cook operation. The high-voltage circuits in a microwave oven generate from 3000Vdc to 5000Vdc and higher. This, combined with the potential for high current, makes the *high voltage circuits of a microwave oven extremely dangerous to work on or around when the oven is energized*. For this reason, most manufacturers pointedly warn that *measuring the high voltage is neither necessary nor advisable*.

It's better (and safer) to avoid making "live" tests if possible. If such tests become necessary, and if you are adequately qualified to do so, the tests can be performed safely as follows:

1. Make sure the oven is unplugged and that the capacitor discharged.

2. Attach the meter leads to the test points with insulated clip leads.

3. Then step back, plug in the oven, perform the test, and observe the meter.

4. In addition, use only one hand whenever possible. Try putting the other hand behind your back or in your pocket. (Two hands could complete a circuit through your body. Use only one hand and/or an insulated tool, even when the unit is unplugged).

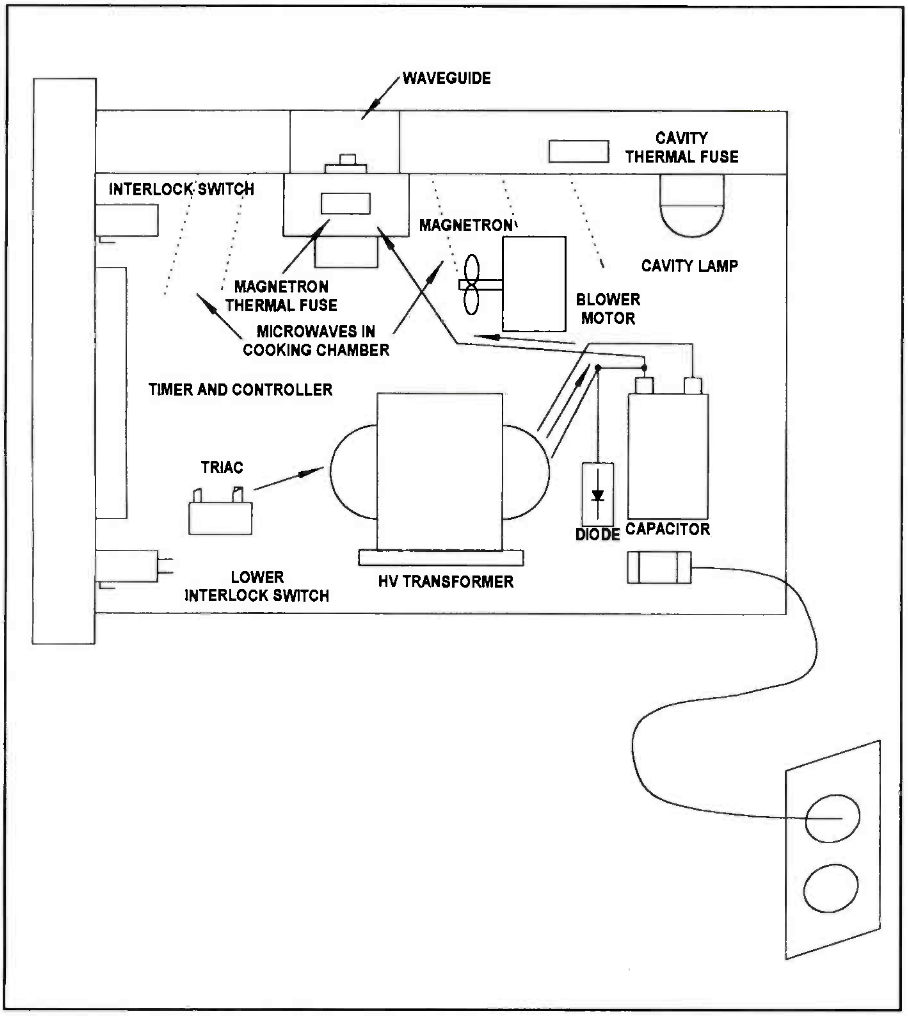


Figure 3. In the high-voltage section, the high-voltage transformer, along with a special diode and capacitor arrangement, increase and rectify the 115Vac ac line to approximately 3000Vdc. This high-voltage is fed to the magnetron tube, which dynamically converts it to undulating waves of electromagnetic cooking energy.

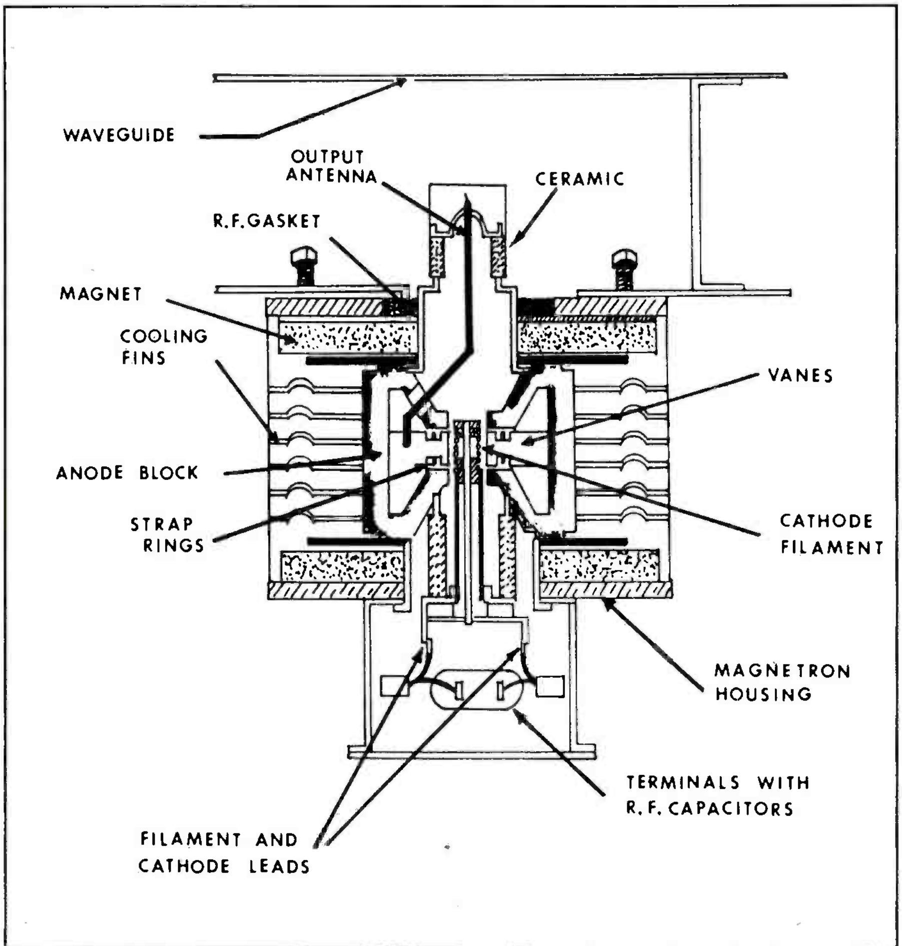
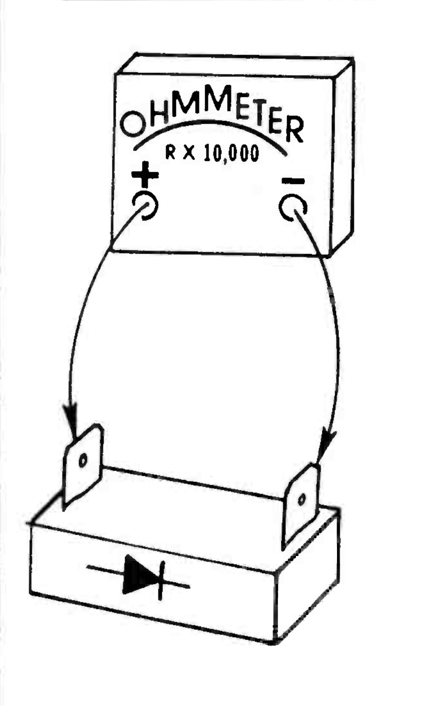


Figure 5. The magnetron tube is the heart of the microwave oven. It produces RF energy and radiates the energy into the cooking cavity where it is absorbed by the food.

Figure 6. The high-voltage rectifier works along with the high-voltage capacitor to effectively double the already high voltage that is provided by the power transformer.



After any adjustment or repair on a microwave oven, manufacturers require that a final microwave leakage check be performed to ensure that the unit does not emit excessive radiation.

Do not work alone. Make sure another person is nearby in case of an emergency.

Use care when lifting and carrying a microwave oven. Remember, in residential models most of the weight is usually on the control panel side.

When lifting a microwave oven, keep your back straight and use your legs, not your back, to do the lifting.

Before carrying, secure the power cord and insure a clear path to your destination.

When lifting an oven in or out of an automobile, lift it on to the seat; do not slide it. Better yet, place a piece of cardboard on the seat first.

Remove your watch and other jewelry. Watches that are susceptible to magnetism will be damaged by the intense magnetic field surrounding the magnetron tube. Moreover, jewelry is electrically conductive and serious injury could result.

Wear rubber soled shoes.

Never defeat or tamper with the safety interlock switches or the fuse.

RF leakage test procedure

If there is evidence that the unit has been previously tampered with by someone of questionable competence, be prepared to check the leakage before energizing the oven.

Most amateurs, and many professionals, do not own an RF leakage meter. These meters are available at appliance and electronic parts suppliers, ranging in price from about $10.00 up to many hundreds of dollars for the certified models used at the professional level.

Inexpensive RF detection devices are also available at many retail stores.

How to test the high voltage capacitor

The high-voltage capacitor works along with the high-voltage diode to effectively double the already-high voltage from the secondary (output) winding of the power transformer. This high dc voltage provides the boost necessary to fire the magnetron into oscillation. Figure 4 is a typical high-voltage capacitor used in microwave ovens. The capacitor can hold a fearsome electrical charge long after the oven has been unplugged. So before making this or any other test: *always make sure the oven is unplugged and the high voltage capacitor is fully discharged.*

How to discharge the high voltage capacitor

The capacitor is discharged by creating a short circuit (direct connection) between the two capacitor terminals and from each terminal to chassis ground (bare metal surface). To discharge the capacitor, perform the following steps:

A. Touch the blade of an insulated-handled screw driver to one terminal, then slide it toward the other terminal until it makes contact and then hold it there for a few seconds. (This can result in a rather startling "snap!" Note: If there is a spark, the capacitor is evidently holding a charge and thus it is most likely not defective)

B. Repeat the procedure to create a short between each capacitor terminal and chassis ground.

C. If the capacitor has three terminals, use the same procedure to create a short circuit between each terminal and then from each terminal to chassis ground.

D. Older Amana-made models (generally those manufactured before 1977) have red, round filter capacitors mounted in the base of the magnetron tube which can also hold a charge. Ground each magnetron terminal by creating a short circuit to chassis ground using the blade of a screwdriver as explained above.

Capacitor test procedure

To test the capacitor, perform the following steps:

1. Unplug the oven.
2. *Discharge all high voltage capacitors.*
3. Note the wiring and carefully remove all leads from the capacitor terminals. (If there is a bleeder resistor, it need not be removed. But, bear in mind that some measurements will reflect the megohm resistance of the resistor)
4. Set the ohmmeter to its highest resistance scale.
5. Measure from one terminal to the other for a normal reading of infinity (or the value of the bleeder resistor).
6. Now reverse the leads. The meter should momentarily deflect toward the zero mark, then slowly drift back to infinity.
7. Reverse the leads once again. This should produce the same meter deflection.
8. Next measure from each terminal to the capacitor's metal case for a normal reading of infinity. (If there is an internal diode, the meter readings will reflect the diode's forward bias resistance. See HV diode test procedure)
9. A visual inspection will also reveal certain defects, such as:
   - Evidence of arcing or burning at the insulators
   - The presence of an oily film or smell suggests a dielectric (non-conductive medium) leak

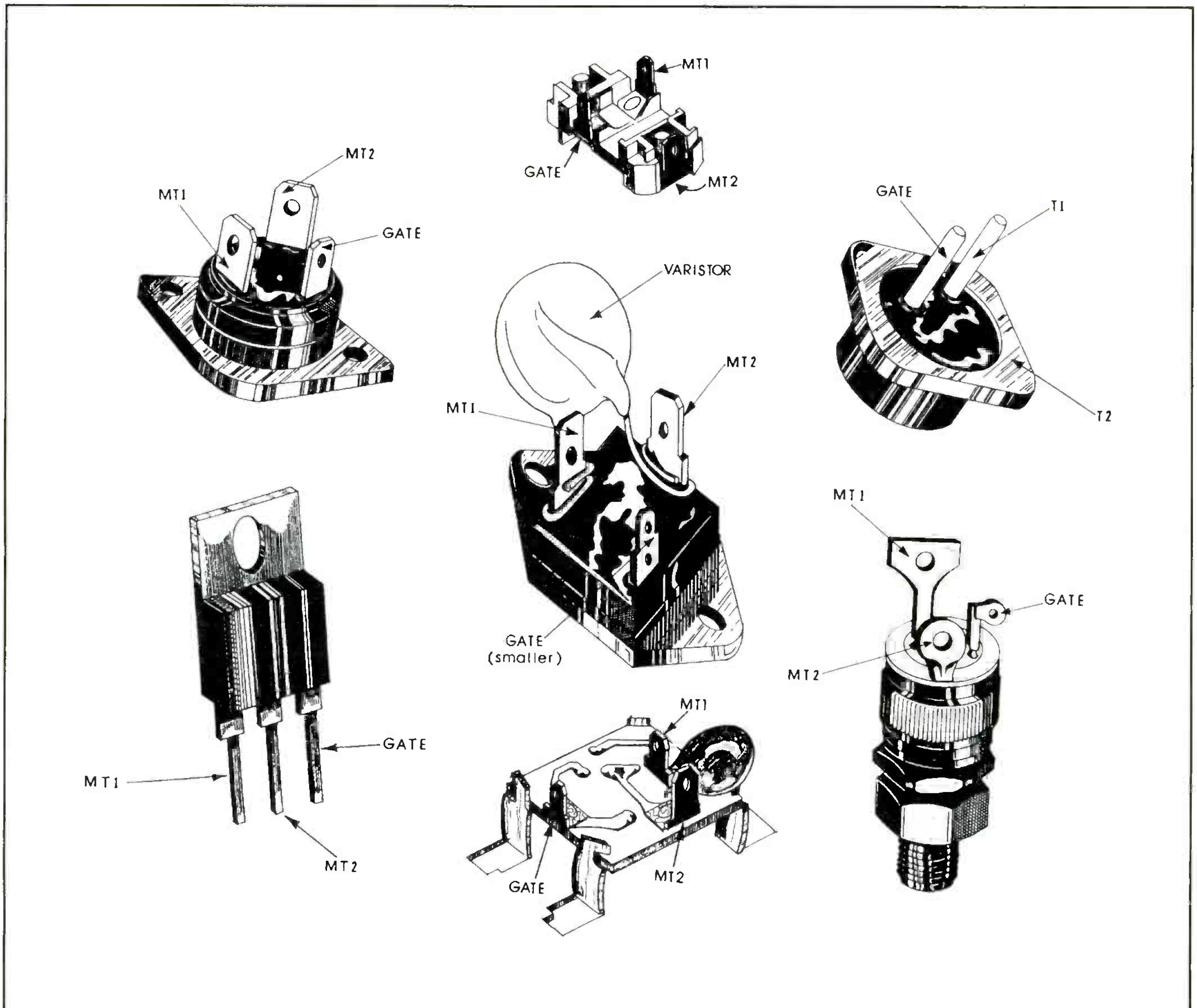


Figure 7. The triac is an electronic relay or switch. Triacs come in many shapes, sizes, and colors. This illustration shows most of the types of triacs that are commonly used in microwave ovens, along with their standard terminal designations.

A few repair histories

Experience has shown that, by means of authentic repair histories, most common problems can be quickly recognized and isolated by simply associating the symptom with the model or brand. Then, with careful observation and/or continuity tests, the problem can easily be diagnosed and solved. Please make sure that you understand and are prepared to carefully follow the appropriate microwave oven repair safety precautions.

AMANA

Model: MC2000MPP (McDonalds Q-ing oven)

Symptom: (1) Door hanging down. (2) Inner door molding cracked (3) Will not go into cook mode

Problem(s): (1) Door hinges (bushings) have worn prematurely, causing the (2) plastic inner door to strike the metal cavity wall when closing the door, and (3) producing a severe misalignment of the door latch mechanism.

Solution(s): (1) Install a hinge upgrade kit, Amana part # R0156889. Price: about $18.00 (2) Replace inner door assembly, Amana part # D7143803. Price: about $60.00 (3) Adjust primary interlock switch for proper actuation.

AMANA

Models: RR-9TA, RR-10A, RR-10H, RR-10ET6

Symptom: Uneven heat and/or inner door has a growing burned spot on bottom edge

Problems: After a period of years, the center of the grease shield begins to sag. This diminishes the air-swirling action that is required to rotate the antenna [which functions to evenly distribute the microwave energy]. (2) The foam-type air gasket material is deteriorated or missing. This gasket serves to channel air from the blower assembly into the antenna chamber where the airflow drives the rotating antenna. A non-rotating antenna creates direct beams of energy that cause trapped particles of food to carbonize and burn into adjacent surfaces.

Solutions: (1) Replace grease shield, Amana part # D7544002, price about $19.00; and (2) install new air gasket material. (3) Replace inner door molding (or liner), Amana part # D7564601. Price: about $30.00

Special instructions: (1) Older models require a special Torx Head driver to remove the 4 screws that fasten the inner door liner to the weldment. (2) The left and right counterbalance arms are attached to springs, so it is necessary to restrain each counterbalance arm with C-clamps before removing the screws. Be sure to protect the black vinyl gasket and any finished surfaces with a piece of cardboard or cloth.

HOTPOINT

Model: J VM 140 001

Symptom: Everything works, but no heat.

Problem: Bad solder connection on harness connector, where it mounts on printed circuit board.

Solution: Re-solder the connections

Note: Access this and similar-model printed circuit boards as follows:

Unplug microwave, open oven door; remove two screws from left side of control panel, freeing left side of control panel.

Slide control panel 1/4" to left to unhook right-hand side and allow panel to pivot downwards

Remove harness connectors and several screws that secure printed board to plastic frame. Defective solder joints are on the other (foil) side.

KENMORE (Sears)

Model: 564.9987960

Symptom: Oven is not heating

Problem: Shorted triac has damaged the triac-drive circuit on the printed circuit board

Test: Triac Test Procedure

Solution: Replace triac (part # 12656, price: about $20.00); also replace the opto-coupler (also called photo-coupler), PH1 or IC1, part # 409-053-9501, and replace the 220Ω 1 watt coupling resistor. Finally, apply non-conductive sealant, such as GE's RTV-102, to the pins of the opto-coupler to prevent moisture from causing erratic operation

MONTGOMERY WARDS

Models: KSA-8014A, KSA-8237A, KSA-8150A

Symptom: Found oven dead after lightning storm

Problem: Built-in surge protection on printed circuit board has opened. This circuit consists of a fine foil pattern (or filter coil — depending on the model) that serves to fuse the primary side of the low-voltage transformer.

Solution: Rebuild the surge protection circuit. Replace the varistor.

PANASONIC

Model: NE-8021, NE-8051, NN-4208A, NN-5407, NN-5500A, NN-5512A, NN-6370WM, NN-6371WM.N, NN-6372AWM, NN-6381A, NN-6482A, NN-6503A, NN-7524AK

Symptom: No heat, weak heat, or intermittent heat

Problem: Magnetron filament connectors have loosened and, due to resistive heat, the terminal connections have deteriorated and burned off.

Solution: Repair defective terminals as follows: Either (1) Cut away burned wire, clean the magnetron terminals, and replace the slip-on connectors, or (2) Cut away burned wire and connector(s). Clean terminals to prepare for soldering. Solder filament leads directly to magnetron terminals. Be careful not to apply soldering heat any longer than necessary

QUASAR

Model: MQ-7700RW, MQ-7757BW, MQ-8768W, MQ-8798H, MQ-8877BW, MQS-1403W

Symptom: No heat. Or, oven counts down but nothing else. Or, starts, then immediately stops

Problem: The slip-on connectors on the upper and/or lower interlock switch have burned loose, possibly damaging the switch.

Test: Interlock Switch Test

Solution: Repair the burned connections by either replacing the slip-on connector(s) or soldering the wire(s) directly to the switch.

Note: If the switch terminal was severely burned, the switch should also be replaced, even if it appears to work normally.

Note: Generic micro-switches rated at 15 or 16 amps with appropriate terminal configuration are available at appliance parts suppliers.

SHARP

Model: R8320

Symptom: Blower fan comes on by itself

Problem: Defective, corroded thermistor (mounted above cavity ceiling).

Solution: Replace thermistor, part # FH-HZ0018WRK0. Price: about $42.00

SHARP

Model: R-3A75, R-4A84, R-4K52, R-5A50, R-5A82, R-5A84, R-5F80, R-5K81, R-4260, R-4840, R-5560, R-5565, R-9200, R-9350, R-9480

Symptom: Arcing in cooking the compartment

Problem: Bits of food or other cooking debris has lodged beneath the waveguide cover (or stirrer cover, depending on the model). After repeated exposure to microwave energy, the cooking residue breaks down into carbon (which a conductor) and arcing occurs. This results in a burned spot in the waveguide cover.

Solution: Clean out all residual grease and cooking debris. Remove all traces of the blackened residue (carbon) from in and around the waveguide opening (use a light grade of sandpaper if necessary, but never use steel wool). Finally, replace the waveguide cover. Price: about $5.00 – $7.00

WHIRLPOOL

Model: MW3500XS-0

Symptom: Control panel just beeps at random.

Problem: Defective keypad (touch panel)

Solution: Replace keypad. Part # 4158199. Price: about $50.00

- A bulging case indicates dielectric breakdown

Any such defects or abnormal readings would require replacement of the capacitor

How to test the magnetron tube

The magnetron tube (Figure 5) is the heart of a microwave oven. Much as a radio transmitter radiates RF signals, the magnetron produces RF energy and radiates the energy into the cooking cavity where it is absorbed by the food. The magnetron uses permanent magnets, high voltage from a half-wave voltage doubler circuit (the HV capacitor and HV diode), and about a 3Vac filament voltage to oscillate and produce the 2450Mhz cooking frequency, thus converting the 60Hz supply voltage into microwave energy.

The following resistance tests will conclusively reveal a magnetron that is shorted or one that has an open filament winding.

Test 1

1. Unplug the oven.
2. *Discharge all high voltage capacitors.*
3. Carefully remove all leads from the magnetron terminals.

Proper wiring is important, so make notes of the wire locations.

4. Set the ohmmeter to its lowest resistance scale.

5. Measure the resistance from one magnetron terminal to the other in either direction.

6. The magnetron filament resistance should be less than 1Ω.

Test 2

1. With the meter set to the highest resistance scale, check from the magnetron terminals to the metal magnetron housing. (Be careful not to touch the meter leads as this will result in a false reading).

2. The meter should read infinity (open circuit) regardless of meter polarity.

3. Even a slight reading would indicate a defective magnetron.

Replacement considerations

If the magnetron tests indicate that the magnetron needs to be replaced, follow this procedure:

1. Be careful not to strike or touch the antenna dome area

2. Be sure to transfer any add-on parts, such as an air duct or thermal fuse

3. Insure that the wire mesh RF gasket is intact and in place

4. Examine the rim of the opening where the magnetron dome is to be inserted into the waveguide. Smooth out any irregularities, such as dents, pits, and burns. The rim surface should be bare metal, smooth to the touch. Use light-grade sandpaper — do not use steel wool.

5. If there is evidence of poor terminal connections (i.e., discolored, burned, pitted connectors) repair or replace the slip-on connectors on the filament leads

How to test the high voltage rectifier (diode)

The high-voltage rectifier (Figure 6) works along with the high-voltage capacitor to effectively double the already high voltage that is provided by the power transformer. This high voltage, about 3000Vdc to 5000Vdc (depending on the model), is applied to the magnetron tube, causing it to produce the microwave energy that cooks the food.

This test requires an ohmmeter with at least a 6V battery to be able to accurately measure the front to back resistance of the diode. Meters with insufficient battery power may read infinite resistance (open) in both directions, mistakenly showing a good diode as being open.

However, the following resistance tests will conclusively reveal a diode that is shorted. In most cases, defective diodes, whether shorted or open, will show some physical signs of the defect, such as a burned crack, a blistered spot, or it may even be split in two. Also, a shorted diode will usually give off a pungent electrical burning odor.

Before making this or any other test: *always make sure the oven is unplugged and the high voltage capacitor is fully discharged*

Test 1

1. Unplug the oven.

2. *Discharge all high voltage capacitors as described above.*

3. Carefully disconnect the lead from the capacitor terminal (the ground connection can remain attached).

4. Set the ohmmeter to read ohms at a scale of R X 10,000 or higher.

5. Measure the resistance across the terminals of the diode by touching the positive meter probe to the anode and the negative probe to the cathode (the cathode is the side that goes to ground, usually marked by an arrow, dot or stripe).

6. A normal diode, depending on make and model, should read about 50,000 to 200,000Ω.

(Note: The polarity of the meter probes, with regard to forward and reverse bias readings, may be relative to the type of meter being used.)

7. Reversing the leads should produce a reading of infinity (open), unless there is a bleeder resistor across the diode, in which case the reading would show the (megohm) value of the resistor.

8. If continuity is read in both directions, the diode is shorted. If infinity is read in both directions, the diode is open. In each case, the diode must be replaced.

In some models, the diode is located inside of the high voltage capacitor. In this case, identify the diode terminal and perform the same test as above, measuring from the diode terminal to the capacitor's metal case.

The purpose of the triac

The triac (Figure 7) is an electronic relay or switch. Triacs come in many shapes, sizes, and colors. The black and white illustration shows most of the types of triacs that are commonly used in microwave ovens, along with their standard terminal designations.

Located either externally or fixed within the controller, the triac operates when it receives an electronic "gate" signal from the control circuitry. It then switches to its closed or "on" state, thereby providing a voltage path to the primary winding of the high voltage transformer, thereby energizing the cook circuits.

Considering the heavy job that the triac does, it's not surprising that it is a common candidate for failure.

How to test the triac

Triacs with three terminals, such as most of those shown above, can be tested by making a series of resistance checks as follows.

Test 1

1. Unplug the oven.

2. *Discharge the high voltage capacitor as described above.*

3. First identify the terminals. The three terminals are generally designated as G (gate), T1, and T2. (A rule of thumb: smallest terminal is the gate; medium sized is T1; largest is T2.)

4. Carefully remove all harness leads. A soldered-in varistor or snubber may remain attached providing it's in good condition.

5. Set and zero the ohmmeter to a scale capable or reading about 40Ω.

6. Measure from the gate to T1, note the reading, then reverse the leads.

7. In each measurement, a normal reading would be in the range of 10 to 200Ω, depending on the model.

8. Next, set the meter to its highest resistance scale. Each of the following reading should produce a normal reading of infinity:

a. From T1 to T2.

b. From T2 to the gate

c. From each terminal to chassis ground

Note: These readings are approximate and may vary with manufacturer, but generally speaking, any results that are significantly different would point to a defective triac.

Test 2

A second way to test the triac is to evaluate its gate-firing capability:

1. Unplug the oven.

2. *Discharge the high voltage capacitor as described above.*

3. Remove all harness leads. Set the meter to a scale capable of reading about 50Ω.

4. Attach the negative meter lead to T1 and the positive lead to T2.

5. Now, using a screwdriver blade, create a momentary short between T2 and the gate. This brief contact should turn the triac "on," thus producing a meter reading of about 15 to 50Ω.

6. Next, disconnect one of the meter leads, then re-connect it. The meter should return to a reading of infinity.

7. Finally, reverse the meter leads and repeat the tests. The results should be the same.

• Any abnormal tests would suggest a defective triac.

• Replacement triacs are generally available at electronic and appliance parts distributors.

The purpose and function of interlock switches used in microwave ovens

To ensure safe operation, all microwave ovens are equipped with safety interlock switches. The door-interlock system is one of the most significant safeguards in a microwave oven. While switch configuration, size, shape, and mounting arrangement may vary from one model to the next, the purpose and basic operation remain the same in all models.

The purpose of the interlock system is to interrupt the production of microwave energy when the oven door is opened, and similarly, to prevent any microwave output until the door is firmly and safely closed.

A principal component of the interlock system is the interlock monitor switch. In August of 1974, a Federal safety standard went into effect that required that all microwave ovens be equipped with an interlock monitoring system. The monitor switch, which is also variously referred to as the safety switch, short switch, sensing switch, and failure detector switch, functions as a fail-safe type of device, in that it disables the microwave oven if an interlock failure should occur. The actual method differs from model to model, but the results are the same: a blown (or opened) fuse.

Generally speaking, the normal sequence of switch operation when the door is opened is as follows. First, the primary switch opens its contacts. Second, the secondary switch opens. Finally, the interlock monitor switch closes its contacts. The fail-safe system works like this: If any of the switches and/or relays included in the monitor loop (or circuit) fail to open their contacts properly when the door is opened, a short circuit is created when the monitor switch closes its contacts. The closed contacts of the monitor switch and the faultily-closed contacts of the defective switch combine to cause an immediate short circuit, which, in one way or another (depending on the model), blows the line fuse, or otherwise disables the oven. All this happens before the door can be opened far enough to allow any dangerous levels of microwave radiation to escape.

All switches have a voltage and current rating. A typical door-interlock switch is rated at 15A–16A with 125Vac or 250Vac applied. When replacing an interlock switch, these ratings must be met or exceeded, otherwise premature switch failure will result. Another replacement consideration is the operating and release force. This is the relative amount of pressure needed to actuate the switch. Various applications call for differing amounts of operating pressure. Like the voltage and current ratings, this is an important factor when obtaining a replacement switch. For example, if the normal pressure of a latch mechanism is insufficient to depress the actuator button, the switch's operating force is probably too high for that application.

The interlock switch to be tested in this example has a COM. (common) terminal, a N.O. (normally open) terminal, and a N.C. (normally closed) terminal. Interlock monitor switches are usually constructed with only the COM and N.C. terminals. Other switches are made with just the COM and N.O. terminals. The following tests will cover most circumstances. Simply disregard the terminal-to-terminal tests that do not apply.

How to test interlock switches

1. Unplug the oven and remove the outer cover.

2. *Discharge all high voltage capacitors as described above.*

3. Visually examine the switch terminals and connectors for signs of overheating, such as discoloration, or brittleness.

• Many times the problem is merely a burned slip-on connector due to a poor crimp joint or weakened connection. If the switch is in good working order, the repair can be made by cleaning the terminals and replacing the burned connector. Or, simply cut off the burned connectors and solder the wires directly to the switch terminals.

4. Carefully remove the harness leads from the switch terminals. Pry them loose if necessary, but do not exert too much force or the terminal may break right out of the switch.

• Many models use a connector with a locking clip in the center of the receptacle terminal. This extruding lever must be pressed down while gently pulling the connector off the terminal.

5. Set the ohmmeter to read ohms at a scale of R X 1.

6. Place one meter probe on the COM. terminal and the other probe on the N.O. terminal. With the actuator (or lever or button) not depressed, the meter should read infinity (an open circuit).

7. Without moving the meter probes, press down on the switch actuator until a "click" is heard. At the point of the click, the meter should swing to a reading of zero ohms (or continuity).

• Rule of thumb: A healthy "click" usually means the switch is working normally. However, switches with just two terminals, both of which come out the back, do not click when actuated and neither do most switch modules.

8. Move the probe from the N.O. terminal to the N.C. terminal. The other probe remains on the COM terminal.

9. Press the actuator and the meter should read infinity.

10. Release the actuator and the meter should read zero ohms.

11. Set the meter to the highest resistance (ohms) scale and measure from the N.C. terminal to the N.O. terminals for a normal reading of infinity.

12. Measure from each terminal to any metal mounting hardware that is part of the switch assembly for a normal reading of infinity.

Any abnormal readings would indicate that the switch is defective and should be replaced.

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Checking the wattage of a microwave oven

Over the years, manufacturers have used several different methods to rate the output wattage of microwave ovens. First, there was the traditional method. Then in 1989–90 came the JIS (Japanese Industrial Standard). Using the JIS method, ovens rated at 700W using the traditional method became 750W ovens. In 1990–91, the industry changed to the international IEC-705 standard. This pushed the wattage ratings even higher. For example, models rated at 700 traditional watts were instantly turned into 800W ovens using the IEC-705 formula.

The following test will provide a suitably accurate measurement of the output power of any microwave oven. Variations or errors in performing this test will produce uncertain results. If the line voltage (from the electrical outlet) is low, the magnetron output will be correspondingly low.

Equipment needed:

• Microwave safe container with 1000mL (1 Liter) gradation.

• Fahrenheit thermometer (Amana part # R0157397) or centigrade thermometer (Amana part # M95D5)

Procedure:

1. Pour exactly 1000mL (1 Liter) of cool tap water into the container. Using the thermometer, stir the water; then measure and record the temperature. For accurate results, the water should be about 60 degrees F (20 degrees C).

2. Place the container on the center of the oven cooking shelf (do not leave the thermometer in the container, and remove any metal racks) and heat the water (at full power) for 63 seconds. Use the second hand of a watch, not the oven timer.

3. After the heating time is completed, immediately remove the container, stir the water, re-measure, and record the temperature of the heated water.

4. Subtract the starting water temperature (step 2) from the ending water temperature (step 3) to obtain the temperature rise.

5. To determine the output power in watts, multiply the total temperature rise by a factor of 38.75 if you're using a Fahrenheit thermometer and by a factor of 70 if you're using a centigrade thermometer.

Dual magnetron systems

Most of the higher-powered commercial models use two 700W magnetron tubes, each with their respective high-voltage systems, which produce a combined output of 1400 watts. Amana's new RC22, DQ22, and MC22 models use three magnetrons to produce a 2200 watt output.

In order to evaluate the independent operation of each individual magnetron, the systems must first be isolated. This is accomplished by disabling one side, then performing an output power test on the functioning side. Either side may be disabled first.

Warning! Before touching components or wiring, be sure the oven is unplugged.

Discharge all high voltage capacitors as described above.

There is high voltage present, with high-current capabilities, in the circuits of the high voltage section. It is extremely dangerous to work on or near these circuits with the oven energized. *Do not touch* components or wiring while the oven is operating. Use very great caution at all times.

The procedure is as follows. Observing the above safety precautions, first disable one side by carefully disconnecting one or both of the leads from the primary side of the high voltage transformer. (See the illustration to the right). Set the oven to cook at full power and perform an output wattage check as outlined above. Having established the functional status of the one side, unplug the oven, discharge the high-voltage capacitors, re-connect the transformer primary wires, and repeat the procedure for the other side.

Commonsense troubleshooting of microwave oven problems

Effective troubleshooting begins with a systematic approach. The objective is to eliminate the cause, not just the symptom. Therefore, the way to a successful repair is guided by mindful alertness and common sense. Here are three basic guidelines:

Be observant and alert to the obvious. Most common problems that occur in microwave ovens are conspicuous and readily detectable by one or more of the senses: your ears, eyes, or nose. For example, *listen* for abnormal, unusual sounds — or the lack of a sound, such as the normal click of a microswitch. *Look* for the obvious: loose or burned connections, disconnected wires, broken binding or melted parts. And don't overlook the presence of any unusual odors. Many times the problem is staring you right in the face.

Keep an open mind. Keep in mind the areas where a particular trouble can *potentially* exist, but don't allow preconceived or indeterminate conclusions to blind you to the real problem. Ask yourself, "what could and could not cause this symptom?" Successful troubleshooting involves a process of logical deductions based on reasonable likelihood, then progressively eliminating all the least likely components until only the most probable suspects remain.

Use your volt-ohm meter. For a final and positive diagnosis, use your volt-ohm meter to make systematic continuity and resistance tests. ■

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Magnavox signal processor III

by Steven J Babbert

In the last two installments of the state-of-the-art TV Series, we have examined various blocks of IC270, the main signal processor, or "TV-chip" used in the Magnavox 25P506-OOAA. So far, we have covered AFT, AGC, audio/video demodulation, and chroma processing. Also discussed were functions such as OSD and electronic picture control that depend on signals from the syscon. In this installment, we will examine the role played by IC270 in generating the horizontal and vertical drive waveforms.

Generation of drive waveforms in early sets

In the early days of television, oscillators produced the horizontal and vertical drive waveforms. If the oscillators were tuned close to the correct frequency, they could be locked to the sync pulses sent with the transmitted signal. The sync pulses were stripped from the composite signal by a sync separator and further separated by passing through differentiator and integrator circuits, which rendered horizontal and vertical pulses respectively. The horizontal and vertical oscillators ran independently and either could lose hold without affecting the other. Some monochrome TVs are still being manufactured with this design.

Waveform generation in more recent set design

In the early 1980s, the so-called "digital countdown" H/V processor chips began to appear. In these integrated circuits, the horizontal and vertical drive signals were obtained by dividing the clock frequency of a master clock. Eventually, these circuits were incorporated into the TV chip. In addition to the 3.58MHz oscillator, these chips held a 503kHz (32H) master clock using an external ceramic resonator to set its frequency. Of course, the exact frequency was still locked to the sync pulse.

The new trend is to derive the horizontal and vertical frequencies by using the 3.58MHz oscillator as the master clock. This is why IC270 only uses a single resonator, Y620. This simplified design is no more difficult to understand or troubleshoot than its predecessor.

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Horizontal start-up

This chassis has a unique feature that will make horizontal drive problems easy to troubleshoot. The horizontal supply pin is typically labeled HOR V_{CC}. The horizontal supply pin in this chassis, pin 35, is labeled HOR ST and is connected to standby supply #2 (Figure 1). This pin should measure about 8V whenever the set is plugged in. Since this supply voltage is always up, horizontal pulses will be output by pin 36 even when the set is off. In other words, there is no start-up "loop" in this chassis to complicate troubleshooting.

The horizontal drive pulses are fed to the horizontal drive transistor, Q501. Next, they are transformer coupled to the horizontal output transistor, Q502. Q501 and Q502 receive their collector supply voltage from source #1. This supply does not come up until the main power supply is turned on by the syscon. In other words, even with drive pulses at the base of Q501, the horizontal output circuit will not run until the chassis is switched on.

There is nothing unusual about the horizontal output circuit. B+ for the HOT is passed through the primary of T502. The scan-derived supply was covered in the April 1998 issue of **ES&T**. The horizontal deflection yoke is connected to the HOT's collector. There is no pincushion transformer because pincushion distortion has been largely corrected through improved yoke design.

The return leg of the horizontal yoke contains a number of components, which act to maintain horizontal linearity. Linearity coil L517 is a magnetically-biased saturable inductor. The core is magnetically-biased close to the point of saturation. As the current increases during line scan, the core saturates and the inductive reactance decreases. This causes greater voltage to be developed across the yoke towards the end of the scan thereby eliminating "squashing" of the right hand side of the raster.

Beam limiter

Picture control input pin 29 of IC270 has two inputs. In addition to the syscon connection, pin 29 is connected to a beam limiter circuit. Excessive beam current during abnormally bright scenes can load the high voltage circuit causing a drop in high voltage. This can cause picture defocusing or blooming. Blooming is a slight enlargement of the picture due to the loss of accelerating force on the beam.

Beam limiter transistor Q661 is normally in cutoff. The emitter is tied to pin 8 of the integrated high-voltage transformer (IHVT). A drop in high voltage (HV) will cause the emitter to go negative with the respect to the base. In this case, the emitter actually goes below ground. The NPN Transistor then conducts, pulling down pin 29 of IC270, causing a reduction in contrast and hence in beam current. Once the beam current returns to normal, Q661 goes back into cutoff.

Vertical output

The vertical output section of these sets is very simple owing to the advanced design of the vertical output chip IC550 (Figure 2). The vertical drive pulse exits pin 44 of IC270 and is routed to pin 2, the vertical trigger input of IC550. This block triggers a one-shot multivibrator, which outputs a pulse suitable for driving a ramp generator. The ramp generator produces a linear sawtooth waveform, which is then amplified by the driver and then applied to the output block. The vertical output waveform exits pin 12 and is applied to the yoke.

The vertical yoke is returned to pin 7 via an RC network and the vertical centering control. This feedback helps to provide linearity electronically; there is no linearity control. The vertical size control, R557, adjusts the bias on the ramp generator, pin 6, to change vertical size.

Notice that pin 6 also has a connection to the beam limiter circuit via trace A3.

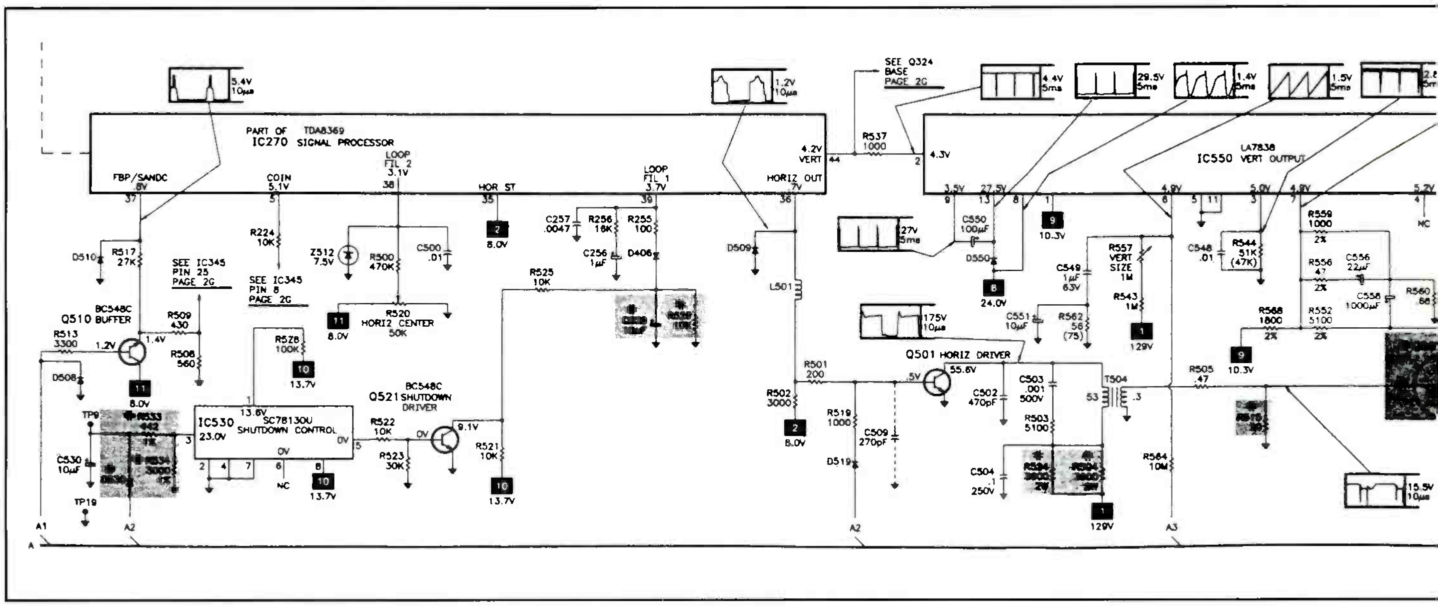


Figure 1. Horizontal, vertical, and shutdown circuits in the Magnavox 25P506-00AA chassis.

This acts to prevent vertical expansion of the raster during bright scenes as discussed earlier.

Excessive beam current will cause pin 6 to drop slightly to dynamically counteract any vertical size increase.

Sandcastle pulse

Most technicians are familiar with the sandcastle waveform used by video processor ICs in many newer TVs. This pulse is a composite of a flyback pulse, a delayed horizontal sync pulse, and a vertical blanking pulse. The three components are mixed outside of the IC. The shape of the pulse resembles someone's idea of what a sand castle looks like, hence the name. Inside of the IC, the sandcastle pulse is used for various functions such as blanking and keying.

IC270 also uses a sandcastle pulse, but the only component coming from outside of the IC is the flyback pulse. The flyback pulse, or FBP, is taken from the collector of the HOT. After being buffered by Q510, it is applied to pin 37. The wider base of the sandcastle waveform is the FBP. If the FBP is missing, the narrow spike will still be present at pin 37, since it comes from within the IC. Without the FBP, the raster will be blank. Always check this pulse if such a symptom exists.

Shutdown

Shutdown is handled by IC530 (Figure 3). This shutdown control IC is fairly complex and was designed to be used in a variety of applications. It is capable of monitoring several parameters and has both latching and non-latching outputs. In this chassis, only a single comparator is being used. The inverting input is tied to a 3.5V reference. The non-inverting input is tied to a tap on a voltage divider between pin 3 and ground.

A tap on the IHVT secondary supplies an ac voltage that is rectified by D530 and filtered by C530. This voltage is applied to pin 3 via a tap on a voltage divider consisting of R533 and R534. When the HV is normal, pin 3 measures about 23V. If the HV rises above normal for any reason, then pin 3 will also rise, causing the comparator's noninverting input to rise above the inverting input. The comparator's output will then go high, causing shutdown driver Q521 to conduct.

Q521 is connected to the loop filter network at IC270 pin 39. When it conducts, C529 will be grounded. This acts to force the horizontal pulse generator to a higher frequency (approximately 16.5kHz); higher frequency translates to a shorter stroke and hence an HOT pulse that is narrower and reduced in amplitude. This lowers the HV to a safe level. Note: In this chassis, excessive HV does not cause shutdown; instead it causes a reduction in HV and a loss of horizontal and vertical sync.

Troubleshooting

If the chassis will not start and you have eliminated the obvious possibilities

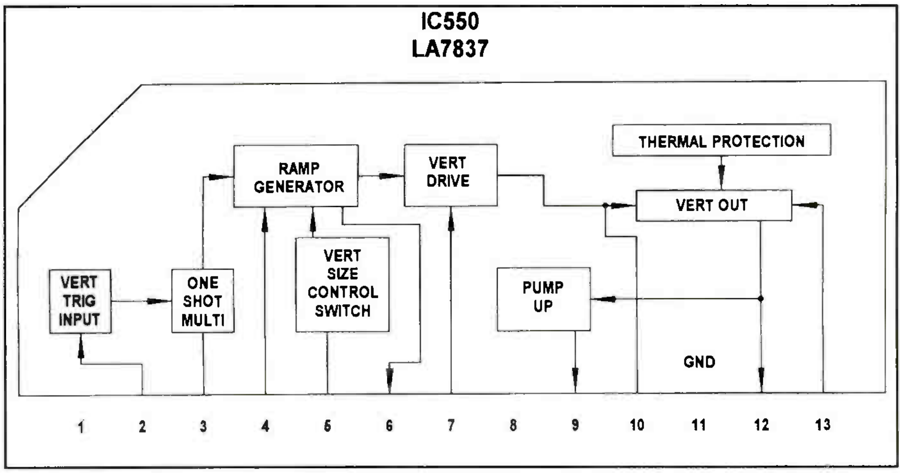
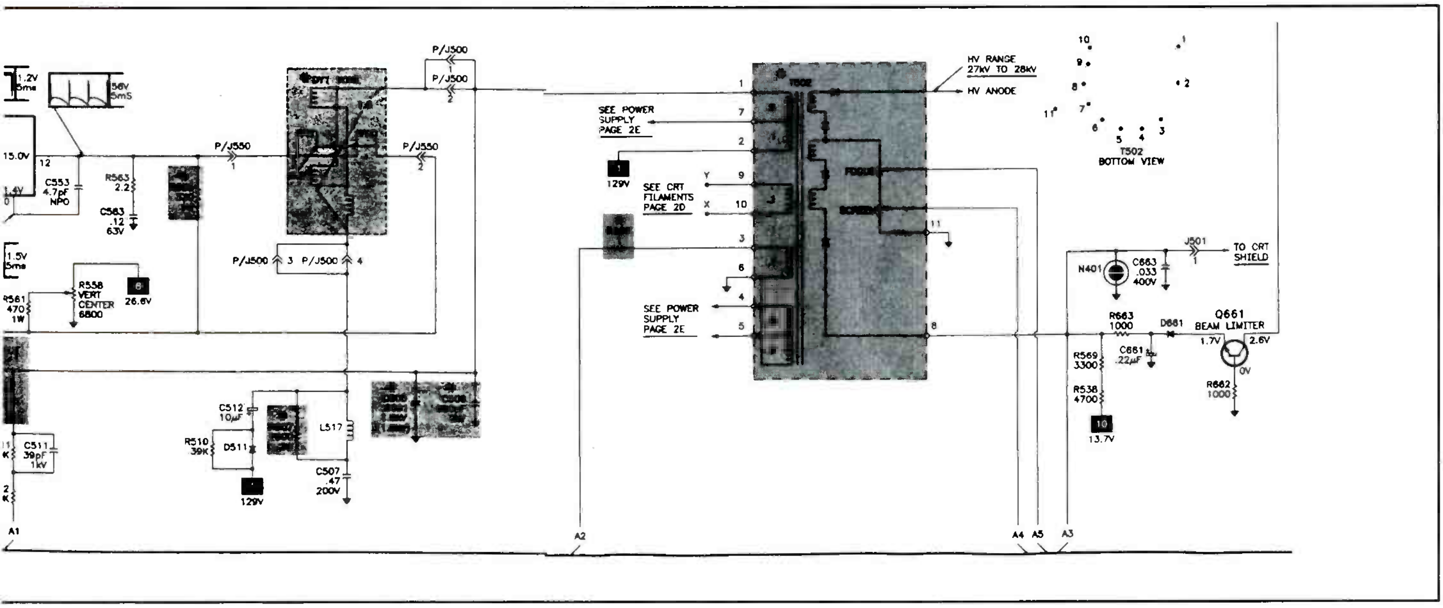


Figure 2. This block diagram shows the functions that are performed by the vertical output IC.



(blown fuse, etc.), check for 8V on pin 35. This comes from the standby circuit and should be present whenever the set is plugged in. If it is not present, remove ac power for a few seconds to reset the syscon (the syscon resets each time the set is plugged in).

Next, measure pin 35 again before the set is switched on. If 8V is present, scope pin 36 to verify the presence of horizontal pulses. If they are missing, IC270 is probably bad. If they are present, then try to switch the set on. If the pulses stop, then the problem is in the power supply, the horizontal output circuit, or the scan-derived supply.

The scan-derived supply takes over HOR ST after power-up; it won't have an output unless the low-voltage supply and horizontal outputs are both functional. The low-voltage supply, however, will power up with, or without horizontal drive. If you can measure 130V at the output of the B+ regulator after the set is switched on, then you can turn your attention towards the horizontal output section and the scan-derived supply. Note: The HOT has an internal 26Ω resistor from emitter to base.

If you find a shorted horizontal drive transistor Q501 and/or charred resistors R504 and R524, then it is likely that the horizontal drive waveform is not reaching the base. In the event that the set is switched on and Q501 has no drive, it will saturate due to bias via R501 and R502. It will then draw excessive collector current via R524 and R504 causing too much power dissipation. After replacing these components, always check for the correct drive at the base before you attempt to power up the chassis.

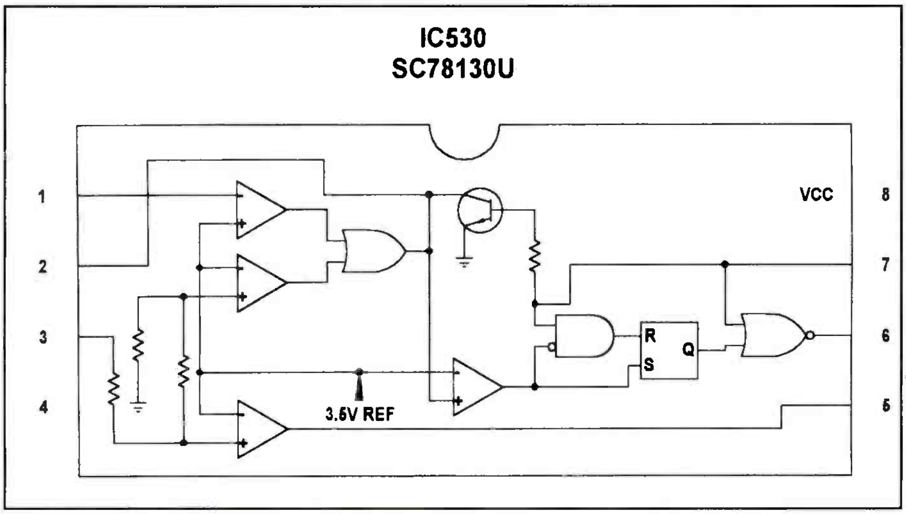


Figure 3. This diagram shows the logic that is performed by the shutdown control IC.

Set in shutdown

If you suspect the set is in shutdown (both horizontal and vertical sync are lost), measure the collector of Q521. If it is near ground, then shutdown is in effect. Disconnect D503 to defeat the circuit then power up the chassis using a variac set to around 90Vac. If B+ does not level off at about 130V as you measure the line voltage, then the regulator must be defective. If the regulator is okay, check capacitors C505 and C506, which tune the output of the HOT.

No vertical drive

If there is no vertical drive as evidenced by a single horizontal line, scope pin 2 of IC550 and check supplies #8 and #9. Both of these are fed via a fusible resistor, R445 (refer to power supply schematic). If drive and power are present, yet there is no output, IC550 might be bad. Before you replace it, be sure to check all associated electrolytic capacitors. Check these capacitors also for size or linearity problems. Don't overlook the possibility of a loose yoke connector, especially for intermittent problems. ■

Books

Internet Industry Almanac, **by Egil Juliussen and Karen Petska-Juliussen, Computer Industry Almanac, Inc., 400 pages, $50 paperback, $60 hardcover**

The *Internet Industry Almanac* is an annual reference book about the Internet industry. It's 400-pages that's authored by two experienced industry observers. It is the most cost-effective resource book in the Internet industry. The *Internet Industry Almanac* has thousands of facts that summarize the industry. There are directories such as: Internet Companies, Internet Publications, Internet Research and Testing Companies, Internet Conferences, Internet People, Internet Resource Directory, Internet Publishers, Internet Associations, and Organizations and Internet Conference Companies.

The Almanac is full of rankings and awards for companies, people, and products. One of the most popular chapters is the salary and wealth rankings of the top Internet people, as well as the average salaries for various Internet-related occupations. It has summaries of Internet market forecasts. There are also estimates of the number of Internet host computers and Internet users for over 50 industrialized countries. A technology forecast focusing on 2000 to 2002 reviews the expected advances and product trends.

An introductory chapter explains the structure of the Internet industry and defines the Internet. Additionally, there is a history of the Internet, employment data, Internet humor, and much more. The *Internet Industry Almanac* was compiled using PCs and desktop publishing and all products used are listed in the *Internet Industry Almanac*.

Computer Industry Almanac, Inc., P.O. Box 4987, 926 Cambridge Drive, Buffalo Grove, IL 60089, Phone: 800-377-6810, Website: http://www.c-i-a-.com

Basic Communications Electronics, **by Jack Hudson and Jerry Luecke, PROMPT Publications, 224 pages, $29.95**

Modeled after Prompt Publications' bestselling titles, Basic Electronics and Basic Digital Electronics, *Basic Communications Electronics* discusses how analog electronic devices and circuits are used to create communications systems. Concentrating on semiconductor devices, bipolar and field-effect transistors, and integrated circuits, this book will teach you how these devices work and how they are used in analog circuits. With the knowledge of basic concepts, device and circuit fundamentals, and circuit applications, you will have a solid foundations that will help you understand the development of communications electronics.

PROMPT Publications, 2647 Waterfront Parkway, East Drive, Indianapolis, IN 46214-2041

ES&T VCR Troubleshooting & Repair, **by ES&T Magazine, PROMPT Publications, 256 pages, $24.95**

Presents information that will make it possible for technicians and electronics hobbyists to service VCRs faster, more efficiently, and more economically, thus making it more likely that customers will choose not to discard their faulty products, but to have them restored to service by a trained competent professional. Originally published in **Electronics Servicing & Technology** magazine, the chapters in this book were articles written by VCR technicians.

PROMPT Publications, 2647 Waterfront Parkway, East Drive, Indianapolis, IN 46214-2041

Handbook for Parallel Port Design, **by James Barbello, PROMPT Publications, 240 pages, $29.95**

This book serves to demystify the parallel port. First addressing the basic tools of inputting-to and outputting-from the port, it will logically progress from the simple to more complex, showing how to use display devices (LEDs) and input sensing devices (such as light-sensitive resistors, IR LEDs, phototransistors, and rotary encoders). Then, it will walk through the design process until the reader has a solid understanding of the parallel port and the skill to use it effectively. Chapter titles include: Basic and Breadboarding, An Optoisolated Hardware Design Environment, Output Solutions, Input Solutions, Sensing Solutions, Dealing With Analog, Designing a Keyless Entry System, and much more.

PROMPT Publications, 2647 Waterfront Parkway, East Drive, Indianapolis, IN 46214-2041

Solid State Amplifiers, **by Joseph Carr, PROMPT Publications, 352 pages, $29.95**

Let this book be your guide to a solid foundation in the realm of amplifiers with a look into transistor amplifiers, including bipolar NPN/PNP transistors, junction field effect transistors, and MOSFET transistors. This book covers the ubiquitous operational amplifier, as well as both audio small-signal and power amplifiers. The radio frequencies are also mentioned. Topics include small-signal RF amplifiers, sold-state parametric amplifiers, monolithic microwave integrated circuits (MMICs), troubleshooting solid-state amplifiers, and selecting replacement parts. Emphasizes the practical end of amplifier technology.

PROMPT Publications, 2647 Waterfront Parkway, East Drive, Indianapolis, IN 46214-2041

RadioScience Observing, **Volume 2, by Joseph Carr, PROMPT Publications, 336 pages, $34.95**

Joe Carr expands on Volume 1 with all-new material, covering: techniques and methods, hardware design and construction, more RadioScience theory, and in response to numerous questions and requests following his first volume, related geoscience and planetary science activities. Discussions will be more skill-oriented and the design and construction more specific, building on the material presented in Volume 1. A CD-ROM with all new material will be included, enabling readers to actually experience the thrills of "listening to the heavens." This book features a special chapter written by Dr. Pauk Schuch of SETI League.

PROMPT Publications, 2647 Waterfront Parkway, East Drive, Indianapolis, IN 46214-2041

Antennas for DTV

by the ES&T Staff

The role of cable television providers in delivery of HDTV signals to their customers still has not been resolved. This means that there will be a lot of viewers in areas where HDTV signals are available who will want to buy antennas so that they will be able to receive HDTV off the air. The type of antenna needed, whether the viewer will be able to get reception by using an indoor antenna, and a number of other questions have prompted the Consumer Electronics Manufacturers Association to develop an antenna selector map program.

This program is designed to assist both dealers and consumers determine the type of antenna they need, based on their location relative to the transmitting antenna. In just about every TV viewing area in the United States, engineers have mapped signal strengths throughout the area and developed color coded maps that show the signal strength available, and the type of antenna that will be needed to capture a usable HDTV signal.

Antenna selector map program

Here are the words contained in a CEMA press release describing the antenna selector map program:

The Consumer Electronics Manufacturers Association (CEMA) announces the launch of the TV Antenna Selector Map Program, a new campaign aimed at making antenna sales easy and rewarding to consumers. Using color-coded maps that match antenna performance, CEMA's new program will help consumers select the appropriate type of antenna for their television reception location, taking the guesswork out of antenna purchases.

"This program provides essential help to consumers and retailers at a critical juncture," said CEMA President Gary Shapiro. "Millions of consumers use antennas to receive free over-the-air television signals, and the need for antennas is greatly increasing. As consumers continue to embrace digital satellite TV systems, such as the Digital Broadcast System (DBS), they are turning to antennas to receive local off-air signals. Additionally, antennas may be the only way for consumers to receive the sensational picture quality and digital surround sound of a high definition television (HDTV) signal until their local cable system passes through HDTV signals. And as new technologies for broadcasting and receiving information and entertainment content emerge, antennas will provide a cost-effective, space-saving solution for receiving these signals. In this dynamic time, CEMA's new program will provide retailers with the tools they need to increase antenna sales and consumers with the tools they need to make the right purchasing decisions."

Companies participating in the mapping program include Channel Master, Gemini Industries, Helios Antenna Systems/HDTV Group, Jasco Products Company, Lance Industries, Leviton Mfg. Co., RDI Electronics, Recoton Corporation, Sony Electronics, Tandy Corporation, Terk Technologies Corporation, Thomson Consumer Electronics, Winegard Company, and Zenith Electronics Corporation. The National Association of Broadcasters (NAB) and the Satellite Broadcasting Communications Association (SBCA) have provided technical assistance.

At the core of the new program are antenna selector maps which have been developed for all 211 designated market areas (DMAs). The maps calculate reception from all full-powered TV stations in a city, including terrain and building obstruction and likely interference. A consumer can work with the retailer to identify the location of their home on the map. Once they have identified in which "color" they reside, they consult the antenna selector guide that explains which types of antennas are most useful. The guide also lists the models available for the reception area. Following voluntary antenna performance specification standards, antenna manufacturers participating in the program will include a stylized CEMA logo with color labels on product packaging that accurately match the guide and the maps, making proper product selection for consumers a snap.

"Never before has the general public had such carefully detailed maps that relate to TV reception," said Neil Terk, president of Terk Technologies Corporation. "The map system was based on extensive lab and field testing, correlating antenna performance with reception environments, and numerous conservative assumptions about home set-up. The program all but assures that when a consumer uses one of the recommended antennas, they will get off-air reception better than ever before. Additionally, the antenna selector project includes the DTV 'planning' factors in its technical assumptions, ensuring that consumers can receive digital television broadcasts through their new antenna."

Retailers can obtain information about the program from their preferred antenna manufacturer or by logging onto <www.CEMAcity.org>. Complete map kits may be ordered from: The Shipyard, 2710 NE Summer Street, Minneapolis, MN 55413; fax: (612) 676-0080, E-mail: mail@theshipyard.com. Retailers can order the kit for $25, which includes an antenna map book for the specified DMA, an informational brochure that explains the program, a technical sheet that reviews more advanced technical issues, five pocket reference guides for salespeople, and a five-minute training video. Consumers can order map kits from The Shipyard at a cost of $49.95 per kit. The Shipyard accepts credit cards (Visa and MasterCard only), a check made out to CEMA, or a money order made out to CEMA. Materials for the Top 30 DMAs were completed and available by mid-December 1998. Materials for all 211 DMAs have been available since the first quarter 1999. Kits will be shipped UPS Ground within 3–4 weeks after the DMA is made available. The kits will be clearly labeled "CEMA TV Antenna Selector Program."

List of DMAs by state

Following is a list of the Designated Market Areas (DMAs) for the CEMA Antenna Mapping program. Maps for all DMAs should be available now.

It should be noted that the mapping program is believed to provide coverage for 90–95% of all households in the U.S. There are certain rural areas that do not fall within any specific DMA.

Major DMAs that had antenna maps available in 1998.

Atlanta
Baltimore
Boston
Charlotte (2 maps)
Chicago
Cincinnati
Cleveland
Dallas-Ft. Worth
Denver
Detroit
Hartsford-New Haven (2 maps)
Houston
Indianapolis
Los Angeles
Miami-Ft. Lauderdale (2 maps)
Minneapolis-St. Paul
New York
Orlando-Daytona Beach-Melbourne (2 maps)
Philadelphia
Phoenix
Pittsburgh
Portland, OR
Raleigh-Durham
Sacramento-Stockton-Modesto
San Diego (2 maps)
San Francisco-Oakland-San Jose
Seattle-Tacoma (2 maps)
St. Louis
Tampa-St. Petersburg-Sarasota
Washington DC

DMAs with antenna maps available 1st quarter 1999

Alaska
Anchorage
Fairbanks

Alabama
Anniston
Birmingham
Dothan
Huntsville-Decatur
Mobile-Pensacola
Montgomery
Tuscaloosa

Arkansas
Ft. Smith
Jonesboro
Little Rock-Pine Bluff

Arizona
Tucson-Nogales
Yuma-El Centro

California
Bakersfield
Chico-Redding
Eureka
Fresno-Visalia
Monterey-Salinas
Palm Springs
Santa Barbara-Sanmar-Sanluob

Colorado
Colorado Springs-Pueblo
Grand Junction-Montrose
Delaware
Wilmington

Florida
Ft. Myers-Naples
Gainesville
Jacksonville-Brunswick
Mobile-Pensacola
Panama City
Tallahassee-Thomasville
West Palm Beach-Ft. Pierce

Georgia
Albany
Columbus
Macon
Savannah

Hawaii
Honolulu

Iowa
Cedar Rapids-Waterloo-Dubuque
Davenport-Rock Island-Moline
Des Moines-Ames
Ottumwa-Kirksville
Quincy-Hannibal-Keokuk
Sioux City

Idaho
Boise
Idaho Falls-Pocatello
Twin Falls

Illinois
Champaign-Springfield-Decatur
Davenport-Rock Island-Moline
Monroe-El Dorado
Quincy-Hannibal-Keokuk
Paducah-Cape Girardeau-Mt. Vernon
Rockford

Indiana
Evansville
Fort Wayne
Lafayette
Paducah-Cape Girardeau-Mt. Vernon
Peoria-Bloomington
South Bend-Elkhart
Terre Haute

Kansas
Joplin-Pittsburg
Kansas City
Topeka
Wichita-Hutchinson

Kentucky
Bowling Green
Lexington
Louisville
Paducah-Cape Girardeau-Mt. Vernon

Louisiana
Alexandria
Baton Rouge
Lafayette
Lake Charles
New Orleans
Shreveport

Maryland
Salisbury

Massachusetts
Springfield-Holyoke

Maine
Augusta
Bangor
Portland-Auburn
Presque Isle

Michigan
Alpena

URLs of participating organizations

The following manufacturers are participants in the CEMA Antenna Mapping program. They can be reached on the internet at the listed URLs.

Channel Master — <www.channelmasterinc.com>
Gemini Industries — <www.gemini-usa.com>
Helios Antenna Systems/HDTV Group — <www.hdtv.net>
Jasco Products Company, Inc. — <www.jascoproducts.com>
Lance Industries — <www.lanceindustries.com>
Leviton Manufacturing Co., Inc. — <www.leviton.com>
RDI Electronics, Inc. — <www.rdi-electronics.com>
Recoton Corporation — <www.recoton.com>
Sony Electronics, Inc. —<www.sony.com>
Tandy Corporation — <www.tandy.com>
Terk Technologies Corporation — <www.terk.com>
Thomson Consumer Electronics — <www.rca.com>
Winegard Company — <www.winegard.com>
Zenith Electronics Corporation — <www.zenith.com>
Other sponsors and program participants:
U.S. Satellite Broadcasting —<www. ussb.com>

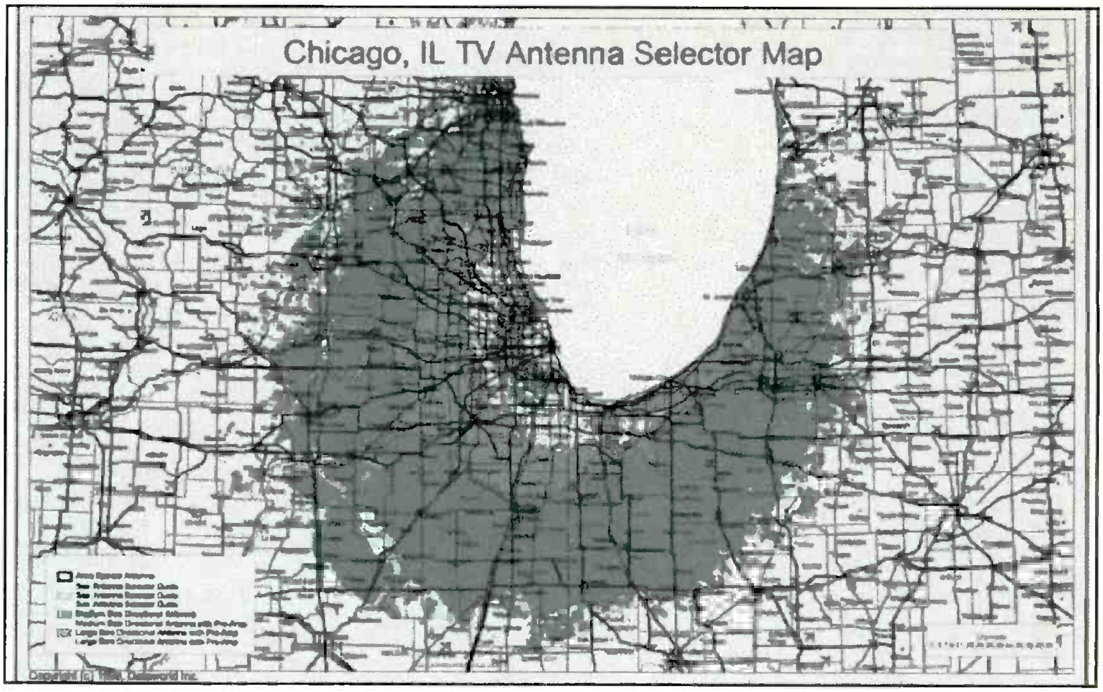
Flint-Saginaw-Bay City
Grand Rapids-Kalamazoo-Battle Creek
Lansing
Marquette
Traverse City-Cadillac
Minnesota
Duluth-Superior
Mankato
Rochester-Mason City-Austin
Missouri
Columbia-Jefferson City
Joplin-Pittsburg
Kansas City
Quincy-Hannibal-Keokuk
Springfield
St. Joseph
Mississippi
Biloxi-Gulfport
Columbus-Tupelo-West Point
Greenwood-Greenville
Hattiesburg-
Laurel
Jackson
Meridian
Montana
Billings
Butte
Glendive
Great Falls
Helena
Missoula
Nebraska
Lincoln-Hastings-Kearny
North Platte
Omaha
New Mexico
Albuquerque-
Santa Fe
Nevada
Las Vegas
Reno
New York
Albany-Schenectady-
Troy
Binghamton
Buffalo
Elmira
Rochester
Syracuse
Utica
Watertown
North Carolina
Greensboro-High Point-Winston Salem
Greenville-New Bern-Washington
North Dakota
Fargo-Valley City
Minot-Bismarck-Dickinson
Ohio
Columbus
Dayton
Lima
Toledo
Youngstown
Zanesville
Oklahoma
Ada-Ardmore
Oklahoma City
Tulsa
Oregon
Bend
Eugene
Medford-Klamath Falls
Pennsylvania
Erie
Harrisburg-Lancaster-Lebanon-
York
Johnstown-Altoona
Wilkes Barre-Scranton
Rhode Island
Providence-New
Bedford
South Carolina
Charleston
Columbia
Florence-Myrtle Beach
Greenville-Spartanburg-Asheville
South Dakota
Rapid City
Sioux Falls-Mitchell
Tennessee
Chattanooga
Jackson
Knoxville
Memphis
Nashville
Tri-Cities, TN-VA
Texas
Abilene-Sweetwater
Amarillo
Austin
Beaumont-Port Arthur
Corpus Christi
El Paso
Harlingen-Weslaco-Brownsville
Laredo
Lubbock
Odessa-Midland
San Angelo
San Antonio
Tyler
Victoria
Waco-Temple-Bryan
Wichita Falls & Lawton
Utah
Salt Lake City
Virginia
Charlottesville
Harrisonburg
Norfolk-Portsmith-Newport
News
Richmond-Petersburg
Roanoke-Lynchburg
Tri-Cities, TN-VA
Vermont
Burlington-
Plattsburgh
Washington
Spokane
Yakima-Pasco-Richland
West Virginia
Bluefield-Beckley-Oak Hill
Charleston-Huntington
Clarksburg-Weston
Parkersburg
Wheeling-Steubenville
Wisconsin
Green Bay-Appleton
La Crosse-Eau Claire
Madison
Milwaukee
Wausau-Rhinelander
Wyoming
Casper-Riverton
Cheyenne-Scottsbluff-Sterling

DirecTV — <www.directv.com>
National Association of Broadcasters — <www.nab.org>
Satellite Broadcasting & Communications Association — <www.sbca.com>

Selector guide and color category review

Antenna maps are broken into seven different color zones. These zones identify that different types of antennas are required in order for a consumer to receive optimal reception. Typically, the closer a consumer lives to the signal tower, the better reception they will receive. They may also be able to use an indoor antenna versus an outdoor. The farther away a consumer lives the opposite is true. However, there are many variables that impact exactly which antenna a consumer will need.

The antenna selector guide can be read in a clockwise fashion starting with the YELLOW zone. Consumers living in this zone typically live closest to the signal tower. Consumers in the DARK GREEN area typically live slightly further out and so on. Individuals living in the RED area may have difficulty with



ghosting (see Frequently Asked Questions) and need to use any antenna with a RED label.

A copy of the Antenna Selector Guide is included in every antenna map book. This allows quick reference by the salesperson as they work with a customer.

Outdoor antenna selector guide

Yellow

Are there any buildings, steeples, towers, or other structures taller than 4 stories within 4 blocks of your receive location? (See Ghost note below)

If you answered No, your antenna choices are:

- Small multidirectional antenna
- Large multidirectional antenna installation may work
- Directional antennas

If you answered Yes, your antenna choices are:

- Medium size directional antenna

(Outdoor installation is best, but an attic antenna might be suitable see attic note below.) (See Ghost note below)

Green

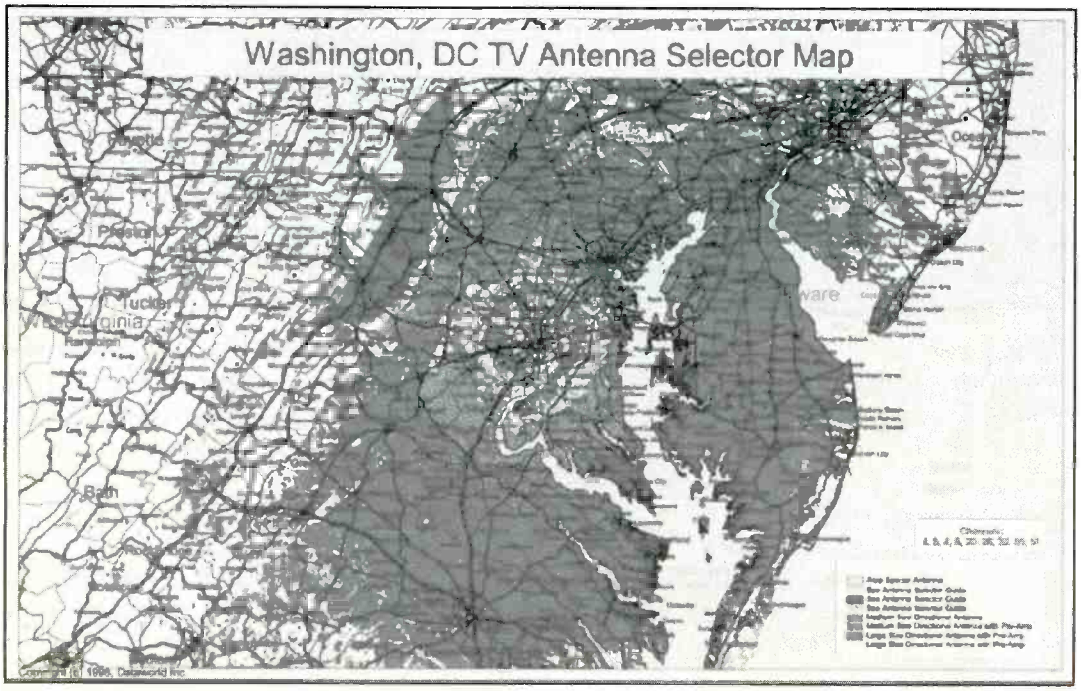
Are there any buildings, steeples, towers, or other structures taller than 4 stories within 4 blocks of your receive location?

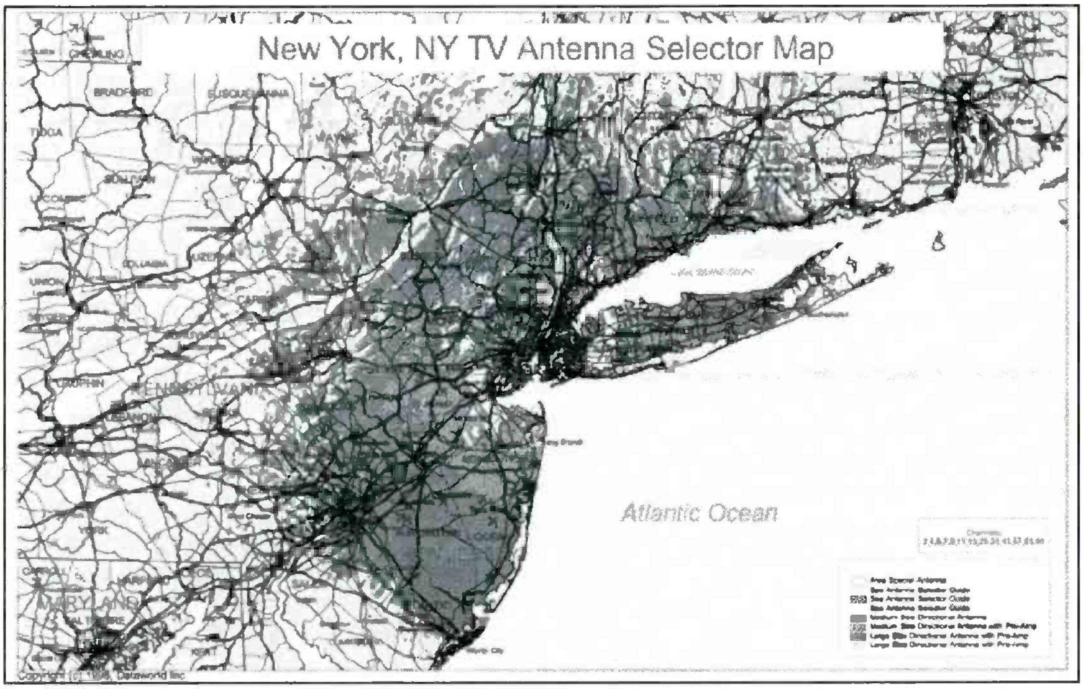
If you answered No, your antenna choices are:

- Large multidirectional antenna
- Directional antennas

If you answered Yes your antenna choices are:

- Medium size directional antenna





(Outdoor installation is best, but an attic installation may work. See attic note below.)

Light Green

Are there any buildings, steeples, towers, or other structures taller than 4 stories within 4 blocks of your receive location? (See Ghost note below)

If you answered No, your antenna choices are:

- Roof mounted, amplified, large multidirectional antenna
- Medium or large size directional antenna

If you answered Yes, your antenna choices are:

- Medium or large size directional antenna

Red: Medium or large size directional antenna

Blue: Rooftop medium or large size directional antenna with antenna mounted pre-amplifier

Violet: Rooftop large size directional antenna with antenna mounted pre-amplifier

Pink: Rooftop large size directional antenna with antenna mounted pre-amplifier will receive at least one station

White: No TV Service from this City (Check other cities in your area)

- Professional tall tower installation
- Satellite delivered network stations
- Cable TV

Ghost note: Many structures can reflect TV signals. This can lead to the TV receiver "seeing" more than one version of the TV signal. When a TV signal arrives at the receiver via more than one path, what is commonly known as *ghosting* results. If the ghosting is caused by a single structure that creates one distinct ghost, a large multidirectional antenna may be useful with careful positioning to eliminate the reflected signal. However, the antenna may require different positioning for each channel. Directional antennas are the most ghost resistant antennas since they "see" in only one direction and tend not to see the reflected ghost signal. The farther away from such structures your antenna is, the less likely you are to have a problem, but many factors such as the structure's total surface area and which direction it faces will make a difference on how much effect the structure will have on your TV reception.

Structures that are likely to cause ghosting: Nearby buildings that are taller than your antenna or block your antenna's view in the direction of the TV station's transmitter like Church steeples, Apartment/Condominium buildings, School buildings, Water Towers, Industrial buildings, office buildings and warehouses, Large communications/ Radio/TV towers or athletic field lighting towers.

Structures that are usually not a problem for TV reception: Trees and foliage (In some cases, foliage can absorb TV signals reducing signal strength, so the best antenna locations will avoid foliage in the direction of the TV station's transmitter) Other homes and residential or commercial wooden buildings that are not taller than your antenna location, street light and utility poles, cellular or PCS poles that are a single pole no higher than tree tops, ham radio antennas, or other TV antennas.

Attic note: An antenna should not be used in an attic unless the antenna selector guide suggests it. Even when that type of antenna will perform well outdoors, reception of TV signals in an attic can be made very difficult due to interference from other electric devices, and building construction techniques that may hinder the entrance of the V signal, or cause reflections of the signal that lead to ghosting.

Indoor Antenna Selector Guide

All indoor antennas will fall into the small multidirectional or large multidirectional antenna category. The CEMA TV Antenna map can only serve as a guide to where an indoor antenna might work. Even when an antenna will perform well outdoors, reception of TV signals indoors can be made very difficult due to interference from other electric devices, and building construction techniques that may hinder the entrance of the TV signal, or cause reflections of the signal that lead to ghosting. The Yellow and Green map areas are where indoor antennas are most likely to work well.

Yellow

Are there any buildings, steeples, towers, or other structures taller than 4 stories within 4 blocks of your receive location? (See Ghost note below)

If you answered No, your antenna choices are:

- Small multidirectional antenna
- Large multidirectional antenna

If you answered Yes, your antenna choices are:

- Medium size outdoor directional antenna (Outdoor installation is best, but an attic installation may work see attic note below.)

Green

Are there any buildings, steeples, towers, or other structures taller than 4 stories within 4 blocks of your receive location? (See Ghost note below)

If you answered No, your antenna choices are:

- Large multidirectional antenna

If you answered Yes, your antenna choices are:

- Medium size outdoor directional antenna (Outdoor installation is best, but an attic installation may work. See attic note below.)

Ghost note: See outdoor antenna selection note. ■

This article was based on information from the CEMA website at http://www.cema.org/.

Products

Visual inspection technology

The O.C. White Co. now offers visual inspection technology in a full range of capabilities, from the SuperScope LCD Vision System, the world's first drop-in replacement for workstation microscopes, to the Vision Lite 2000 Illuminated magnifier with patented dimmable fluorescent lighting.

The SuperScope LCD Vision System is a turnkey production tool, consisting of a flat LCD monitor and high-resolution camera with an integral illumination system. The high resolution LCD color viewing monitor allows the user to view the LCD screen from any comfortable angle, and makes viewing easy and crisp, eliminating the multiple problems of narrow field of view and physical discomfort.

The Vision Lite 2000 features the world's first dimmable fluorescent illuminated magnifier and is available in 2 different lenses. The bulb's unique design provides three-sided illumination, eliminating annoying shadows and micro-chip controlled ballast technology eliminates all fluorescent flickering.

O.C. White, 2039 Bridge Street. Three Rivers. MA 01080, Phone: 413-289-1751, Fax: 413-289-1754. Website: www.ocwhite.com

Circle (80) on Reply Card

E:fact!

Howard W. Sams has introduced E:fact, an electronically viewable service manual in PDF format that is created directly from Sams PHOTOFACT, incorporating most of the features that has made Sams service data the industry-wide acknowledged leader in professional service literature. This electronics service data provides same day access to the most reliable and cost-effective service documentation on the market.

Included with each service document are the following features: Standard notation Sams style schematics; All source voltage locations; Waveforms at all important test point locations; Detailed electronic parts lists for all major components with cross references for semiconductors; Placement charts showing the location of active components on all circuit boards; Hotlink features that will help you navigate the documents.

These documents are available for most brands and models of televisions built from 1992 to date.

Howard W. Sams, 2647 Waterfront Parkway East Drive. Indianapolis. IN 46214-2041. Phone: 317-298-5400. Fax: 317-298-5604. Website: www.hwsams.com

Circle (81) on Reply Card

HDTV antenna

Godar Electronics introduces the Super Antenna Model 2, high definition TV antenna.

The unit is a portable flat compact yagi HDTV antenna. This is applicable for high-end FM applications (non-amplified noise free) reception. Broadband passive yagi design for analog digital, VHF, UHF, FM stereo reception.

Model 2 was designed for placement on home theater wall units, and big screen TVs. It's also excellent for tight crawl spaces and attics (height is 1") and requires no mounting hardware.

The antenna is designed for apartment, condo tenants, and home owners where outdoor antenna installations are restricted. Model 2 is applicable for current standard television reception.

Godar Electronics, 339 N. Gilbert Road. Gilbert, AZ 85234, Phone: 480-892-8207

Circle (82) on Reply Card

3M Scotch-Brite cleaning cloth

3M announces the Scotch-Brite High Performance Cloth for cleaning electronic and electrical components.

The cloth uses a knitted, interwoven design of water and oil absorbing microfibers that lift and trap liquids, grease, dust, and dirt particles. It can remove solvents, dust residue, abrasive, splatters from welding, compounds, polish residue, waxes, fingerprints and grease and silicone from injection molded parts.

3M Electrical Products Division, P.O. Box 3064, Cedar Rapids. IA 52406, Phone: 800-276-0049

Circle (83) on Reply Card

Antenna selector website

Decisionmark announces the release of its web-based technology for selecting the appropriate off-air antenna. The technology was developed to assist retailers and consumers in determining the appropriate off-air antenna based on a consumer's location and viewing habits.

The first applications of the antenna selector technology are evident in <iwantmyfreetv.com> and <antennaselector.com>. Iwantmyfreetv.com is a Web-based antenna selecting and purchasing site wholly sponsored by Winegard Company.

Antennaselector.com is an online antenna selecting and purchasing product for multiple antenna manufacturers. Both sites will help consumers select the appropriate antenna for their household locations. A consumer just enters his or her address and the stations they care about watching and the antenna selector technology recalculates on the fly the appropriate off-air antenna for that particular location. The technology allows the consumer to map the location of the broadcast towers relative to their particular household. This simplifies the process of installing off-air antennas. There are three options at the end of the selection process in <antennaselector.com>: online purchasing, local dealer referral, or professional installation.

Decisionmark, 200 Second Ave., S.E., Suite 300, Cedar Rapids. IA 52401-1201. Phone: 319-365-5597. Fax: 319-365-5694. Website: www.decisionmark.com

Circle (84) on Reply Card

Servicing RCA's CTC166 and CTC167 low voltage circuits

by Homer L. Davidson

Faults in the low voltage power supply circuits in the RCA CTC166 and 167 chassis produce a variety of symptoms:

- dead chassis,
- shutdown,
- pulsing off and on,
- failure to turn on,
- intermittent problems,
- no remote action,
- and improper standby voltages.

As in most modern TV chassis, in these sets the horizontal output and flyback circuits must operate before scan-derived voltage sources are active. The horizontal output transistor must have correct drive voltage from the horizontal deflection circuits and raw dc voltage from the power supply before the flyback voltages are developed (Figure 1).

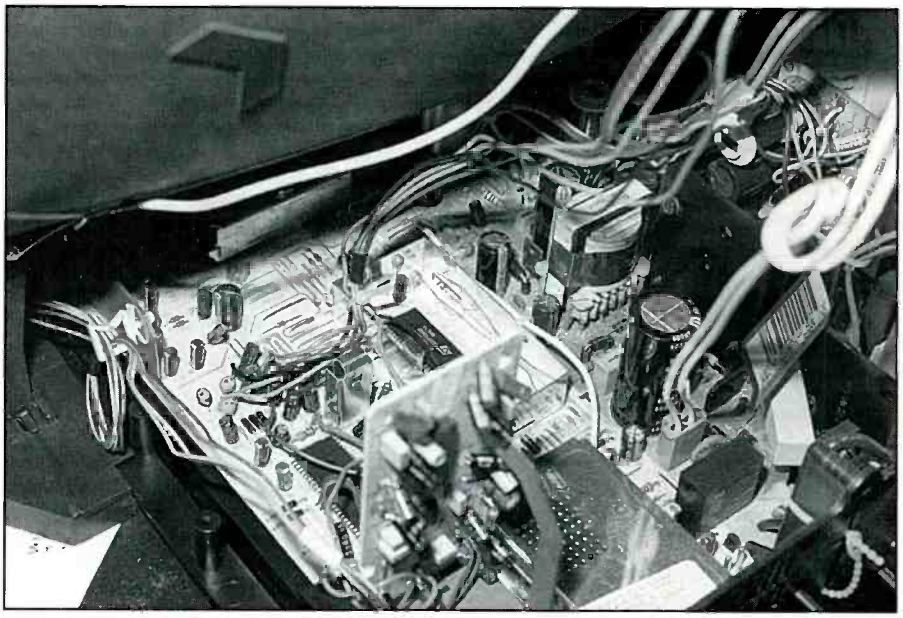


Figure 1. The flyback and horizontal TV circuits found in the RCA TV chassis.

In the beginning

Some manufacturers supply a fixed voltage from the low voltage circuits to provide supply voltage directly to the horizontal deflection IC. In the RCA CTC166 and 167 chassis, however, the 9Vdc supply that for the deflection processor IC (U1001) is scan-derived from the flyback circuits and fed to pin 16. With this type of arrangement, the low voltage power source, the horizontal circuits, and the flyback power source must all function to operate the entire TV chassis. If any of the above circuits are defective, the chassis might not fire up and remain shutdown.

Excessive high voltage, or chassis shutdown?

If this TV will not operate, the first step for the service technician to take is to determine if the cause is excessive high voltage, or if this is simply chassis shutdown. In this set, the high voltage is monitored by diode CR4901, which rectifies the pulses from the flyback (T4401). If the high voltage should increase, the rectified voltage at the cathode of CR4901 will also increase. This voltage increase triggers zener diode CR4409 and the chassis shuts down.

To troubleshoot this symptom, start by disconnecting power to the set and disconnecting one end of CR4901 from the circuit. Now, connect the set through a variable voltage transformer (often called by a brand name of one brand of variable voltage transformer, "Variac"). Start with voltage output of the transformer near 0V, and slowly increase the voltage to the set. Make a note of the ac voltage at which the chassis shuts down.

If the chassis shuts down before the transformer voltage reaches normal power line voltage, this is high-voltage shutdown, and the problem is somewhere in the high voltage and/or horizontal circuits. To cure the problem, troubleshoot the high voltage and horizontal circuits to isolate the problem. Resolder the end of CR4901 after repairs are made. If you determine that the chassis is not in high voltage shutdown, check the horizontal deflection circuits.

Checking the horizontal circuits

To determine if the horizontal circuits are operating, disconnect the set from the ac line and inject a +9Vdc source at pin 16 of U1001. With the 9V source feeding pin 16, scope pin 64 of U1001 to see if there is a square waveform at that point. If you find a square waveform at pin 64, you know that the deflection circuits are okay. Next, check for a vertical waveform at pin 55. If there is no waveform at the vertical or horizontal output pins, the horizontal IC (U1001) and related circuits must be repaired before servicing the low voltage power supply circuits.

Inject a horizontal drive signal at the base of the horizontal output transistor (Q4401) to determine if the horizontal output circuits are normal. If horizontal deflection is now present, check the waveforms and components associated with pins 57 through 64 of U1001. If by chance there is no horizontal deflection, check Q4401, and the voltage and waveforms

Davidson is a TV servicing consultant for ES&T.

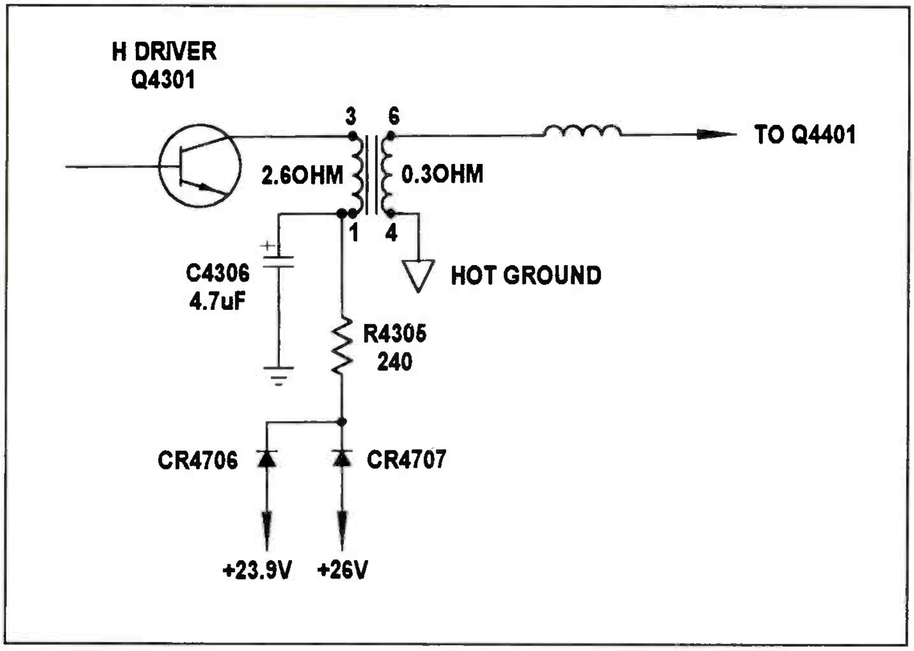


Figure 2. Whenever you service the low-voltage circuits of one of these sets, resolder all terminals of the driver transformer T4301 and check R4305, C4306, and CR4707 for correct value.

connected to the horizontal output transformer (T4401). Determine if the raw 165V and 129V sources are functioning.

Dead symptom

The components that are most likely to cause a dead chassis are components that comprise the low voltage power supply, or a blown fuse, leaky silicon diodes, or electrolytic capacitors. Most technicians check for a leaky horizontal output transistor if the line fuse has opened. A quick ohmmeter test from the collector terminal to common ground indicates if the output transistor is leaky or shorted. In the case of the CTC166 and CTC167 chassis, the test of the horizontal output transistor for leakage should be made from the collector terminal to the hot ground.

If Q4401 has leakage or is shorted, replace it with the exact part number, 171142, or a universal replacement (such as the NTE2331, ECG2331, or SK10088). Before leaving the horizontal section, resolder all four horizontal driver transformer board connections. Notice that the secondary winding of T4301 is at the hot ground side.

As long as you're working in this area of the circuitry, test both diodes CR4606 and CR4707 to see if they're shorted or have leakage. Then operate the set for a while to make sure it's operating properly. Check the temperature of Q4401. If it operates too warm after a few hours of operation, replace C4306 (4.7µF). Other possible causes of a dead or shutdown chassis are T4301, R4305, C4306, and CR4707 (Figure 2).

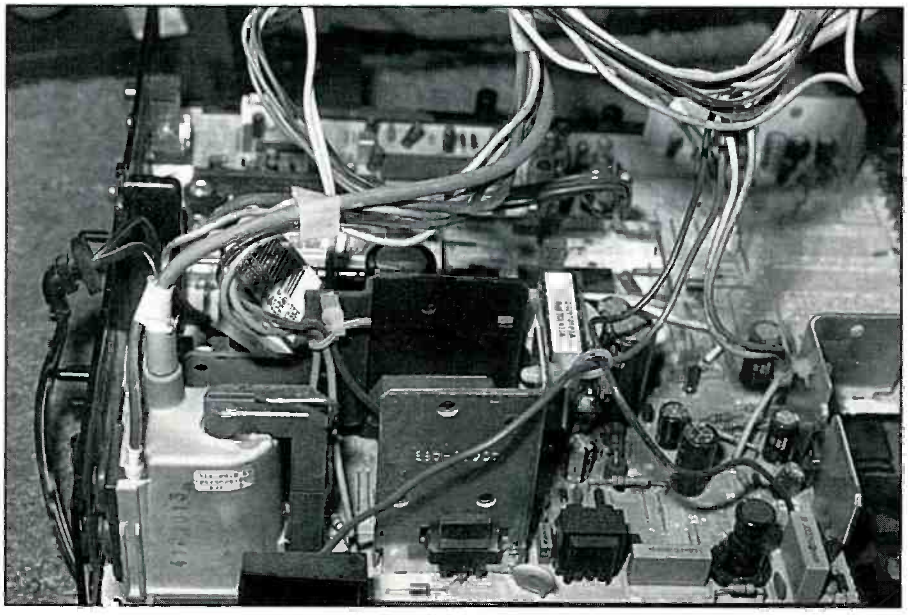


Figure 3. If there is raw 150V across C4007, but no voltage to Q4401, suspect components in the error amp, sawtooth generator, and SCR4101 circuits.

Shutdown symptoms

The horizontal and low voltage power supply circuits in the RCA CTC166 and CTC167 chassis are identical. Although some of the service problems encountered in one of these chassis might be different than those found in the other chassis, a number of problems are common to both chassis. The most common chassis shutdown problem in the low voltage power supply circuits are caused by transistors, diodes, zener diodes, changes of resistance, and a defective microcontroller IC.

When you're troubleshooting a shutdown problem, check for a raw 150V across the large filter capacitor, C4007 (680µF, 200V). If voltage is present here, but there is no applied voltage to the horizontal output transistor, Q4401, suspect components within the error amp, sawtooth generator, and SCR4101 circuits (Figure 3). This can be verified if you measure 150V or higher at the anode terminal and 0V at the cathode terminal. Check the waveform at the gate terminal of SCR101 and coupling transformer T4101.

When SCR4101 has a high dc voltage (153V) at the anode terminal and 0V at the anode, the SCR might be defective. Although SCRs cause only a few service problems, if you suspect this SCR, you can check it in a diode tester, or with ohmmeter resistance tests. Remove the SCR for diode and resistance tests. The normal SCR has a resistance of around 50Ω from the gate to cathode and infinite resistance from anode to cathode or cathode to anode. If in doubt, replace SCR4101 with the original part number, 197591.

In circuit transistor tests of Q4104, Q4103, Q4102, and Q4101 can quickly locate a defective transistor. Some shut-

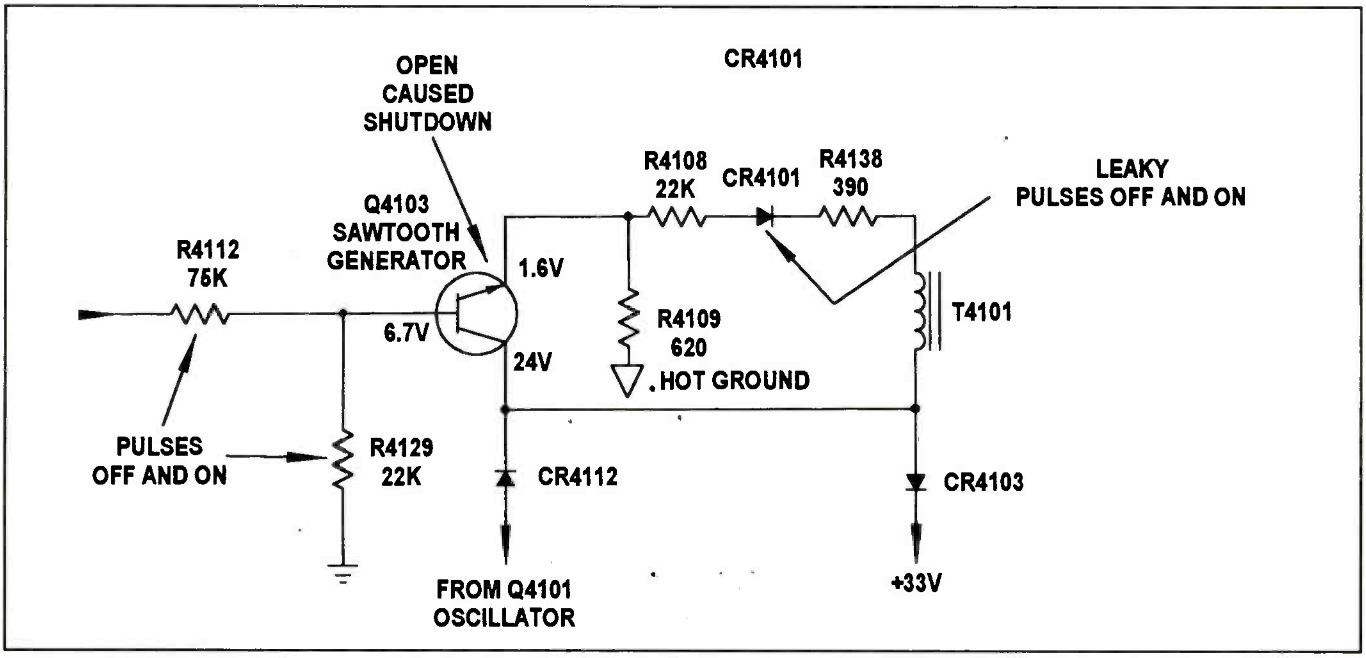


Figure 4. Replace Q4103 for chassis shutdown and CR4101 if the set cycles off and on.

down problems in both of these chassis have been traced to an open or leaky sawtooth generator transistor, Q4103, (Figure 4). If you strongly suspect that this transistor is bad, replace it with the a manufacturer's exact replacement, 146847, or a suitable universal replacement.

Next, check all diodes and zener diodes in the low voltage power supply circuits; there are quite a few of them to be tested. A quick diode test with the DMM can locate a leaky or shorted diode. Zener diode CR4120, found in both chassis, has caused chassis shutdown.

If CR4104 in the 33V supply is faulty, it can cause the chassis to come on and sometimes produced a cycle on and off symptom. Intermittent shutdown can result from a leaky zener diode CR4160 and CR4161 in the standby voltage power supply circuits.

Pulses off and on

There are quite a few different components in the power supply of the CTC166 and CTC167 chassis that can cause the set to cycle on and off. This symptom can be caused by defective diodes, capacitors, and resistors. When the set pulses off and on, you can hear a noise in the flyback. In most cases, high voltage never comes up before the chassis shuts down.

When you encounter a set that pulses off and on, test all diodes in the error amp and sawtooth generator circuits to see if they have leakage, or are open. In most cases when it's a diode that's causing the set to cycle on and off, the diode has developed leakage and should be replaced. If you suspect a particular diode, disconnect one terminal from the circuit and check it with the DMM. If the results of the diode tests aren't conclusive, replace the diode.

When diodes CR4101 and CR4103 in the sawtooth generator circuits develop leakage, they have caused cycle on and off service problems in both TV chassis. When this area of the circuitry is the cause of the problem, automatically, replace C4108 (0.0033μF) capacitor shunted across CR4103 (Figure 3). In some cases, when the problem is pulsing on and off of the set, CR4101 in the 33V source has been found to be the cause. The 33V source supplies operating voltage to the error amp, sawtooth generator, and oscil-

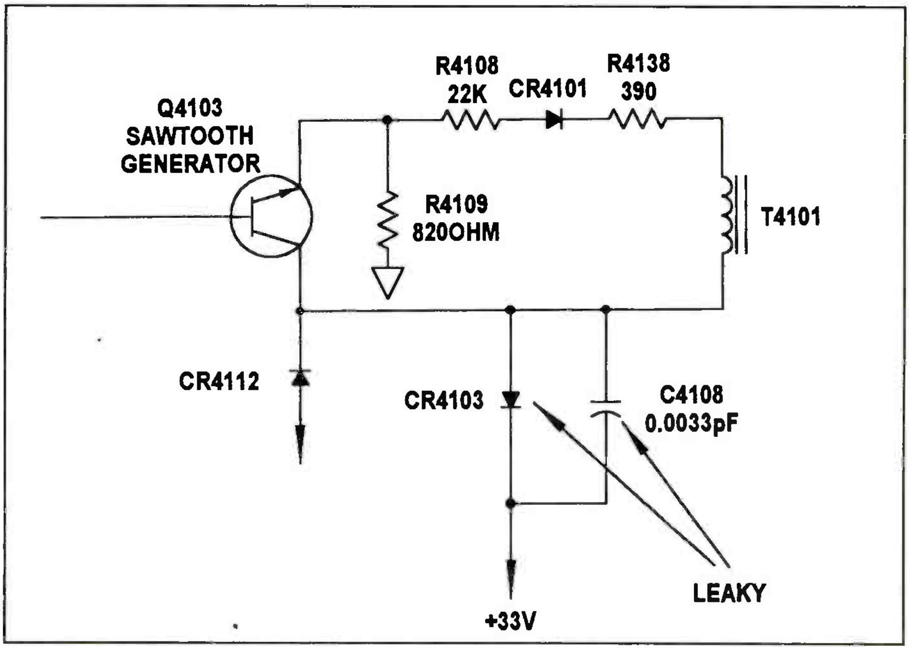


Figure 5. Replace both CR4103 and C4108 if the set pulses off and on and you find these diodes to have leakage.

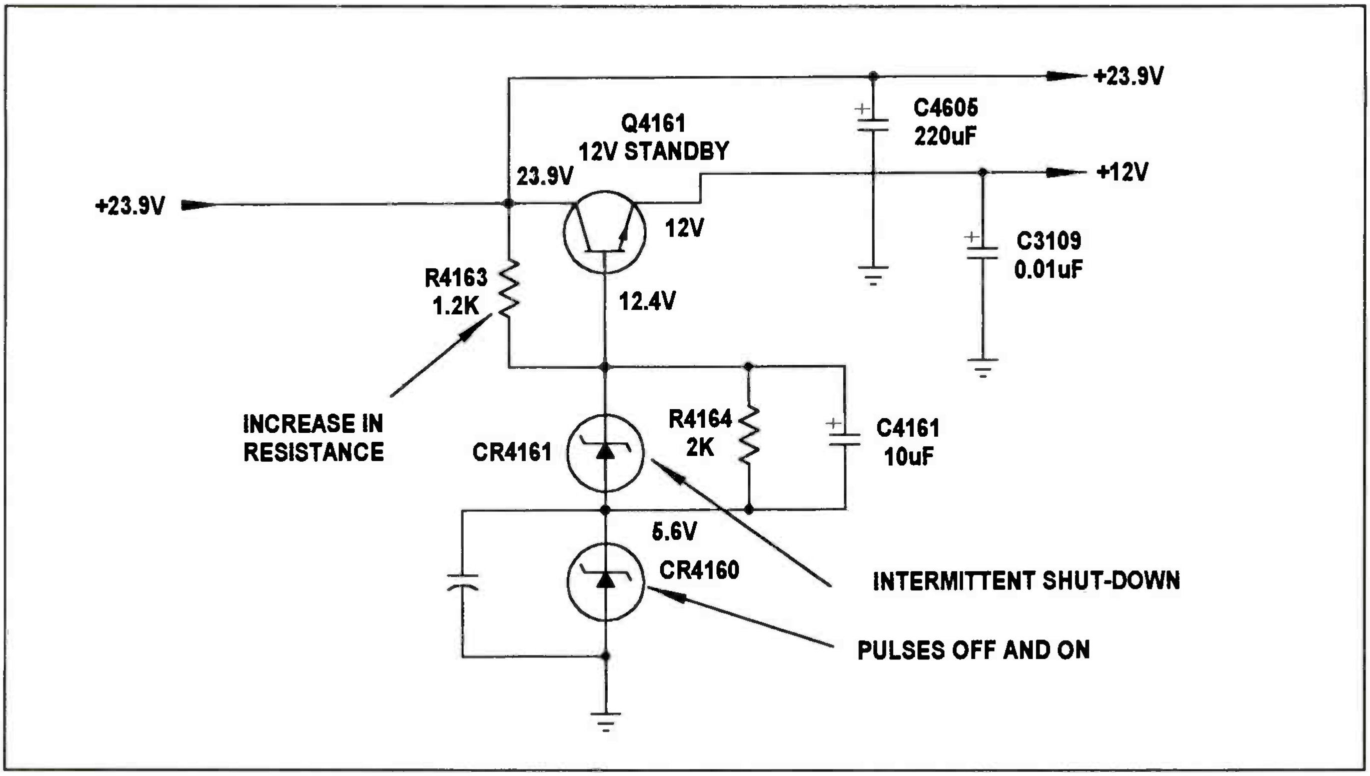


Figure 6. Replace CR4160 and CR4161 if the set shuts down intermittently or cycles off and on.

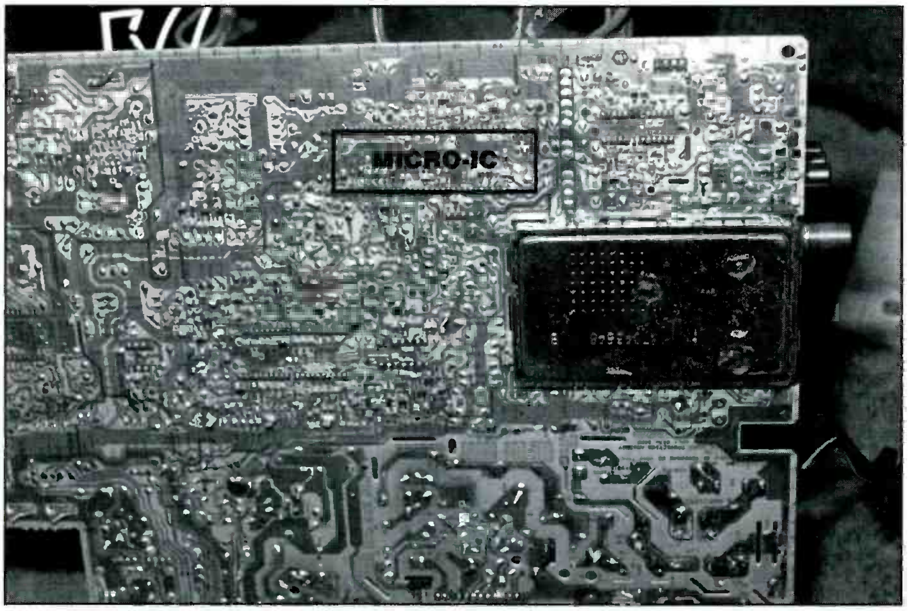


Figure 7. If the microcontroller, U3101, is defective, it can cause chassis shutdown.

lator circuits in the low voltage circuits. Notice that the voltages are measured with the ground probe of the DMM connected to the hot ground.

Another cause of pulsing on and off in these sets is increase in resistance of large value resistors. R4116, R4117, R4118, and R4175 are critical resistors within the B+ factory adjustment circuits. R4175 (41.25KΩ) has caused cycle off and on symptoms. These voltage divider resistors are very critical in value and should be replaced by the original part numbers.

R4129 (22KΩ) resistor within the base circuit of the sawtooth generator (Q4103) can increase in resistance and cause the set to pulse on and off. Remove one end of each resistor for accurate resistance measurement. Check R4163 (1.2KΩ) and R4164 (10KΩ) resistors within the standby regulator power supply whenever you encounter one of these sets that is dead or that cycles on and off.

No standby voltages

The standby voltage regulator circuits are located in a separate standby voltage power supply. The primary winding of T4601 is wired directly to the power line and is on all the time for remote and microcontrolled circuit operations. Diodes CR4601, CR4602, CR4603, and CR4604 are connected in a bridge circuit with a + 12V and +5V regulated transistor standby voltage sources. Electrolytic capacitors C4605 (2200μF) and C4160 (1500μF) provide filtering in the +5V and 12V power standby circuits.

Most problems in the standby circuits are caused by leaky or shorted diodes, leaky or open regulator transistors, and defective electrolytic filter capacitors. Check all zener diodes for leakage, and check visually to see if there are signs of overheating. An open standby regulator transistor results in 0V at that source. A change in resistance of R4163 (1.2KΩ) and R4164 (2KΩ) can cause a dead chassis. The chassis might not turn on if the

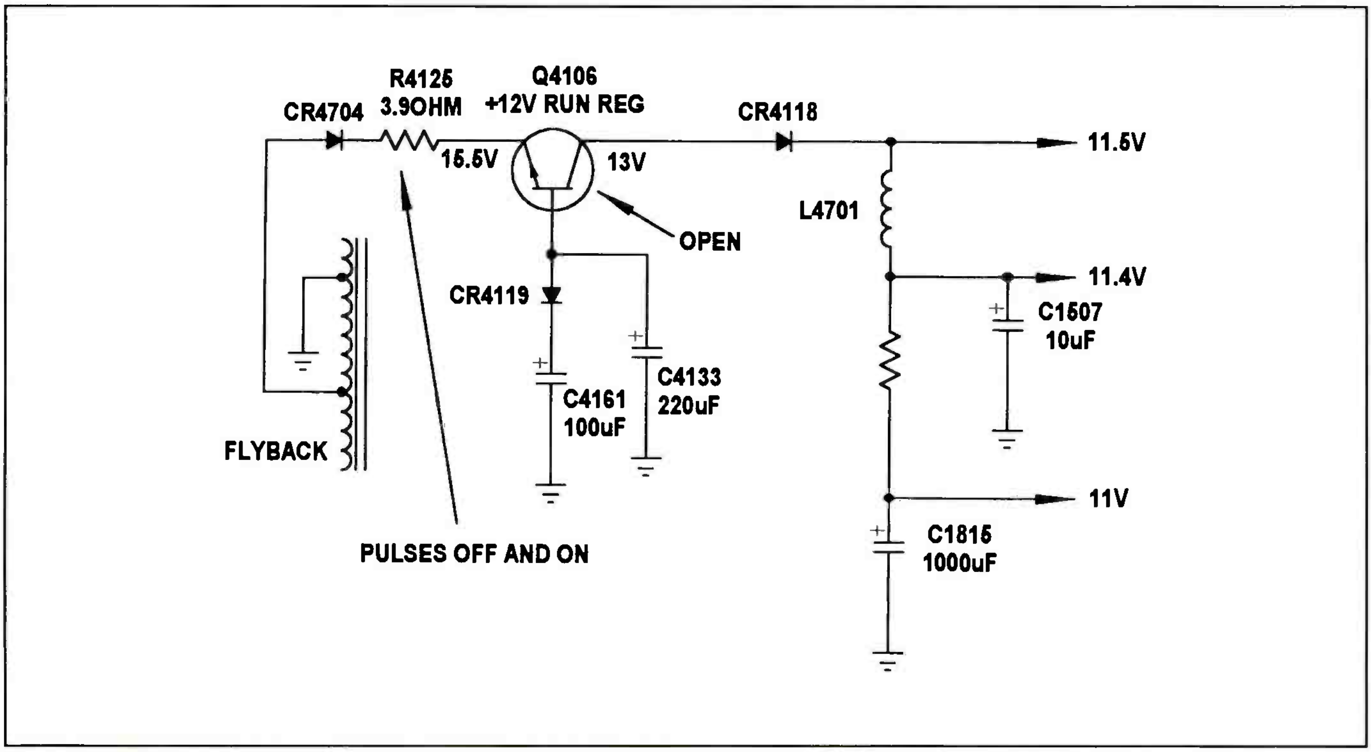


Figure 8. Open R4125 (3.9Ω) resistor can cause a shutdown symptom. A change in resistance of this resistor can cause the set to cycle off and on.

resistance of R4163 has increased significantly. Check diodes CR4160 and CR4161 when you encounter a set that exhibits symptoms of intermittent shutdown or pulsing on and off (Figure 6).

Improper voltage applied to the microcontrolled processor (U3101) terminals can be caused by electrolytic capacitors in the standby voltage sources (+12V and +5V). Check the voltages on U3101 before replacing the microcontrolled IC.

Outside the low voltage power supply

The cause of intermittent shutdown service problems may be found outside of the low voltage power supply. Since the standby circuits supply voltage to the microcontrol circuits, a defective component within these circuits might cause chassis shutdown problems. Chassis shutdown can result from an increase in resistance of R3118 and R3117, which are connected to pin 6 of U3101 (Figure 7). Disconnect one end of each resistor when you measure them, to make sure that a component in parallel with it doesn't cause an incorrect value.

A defective microcontrol processor (U3101) can cause chassis shutdown. Its best to check all other components that might shut the chassis down before removing U3101. U3101 has many pin terminals and takes time to replace. Measure the voltage on each IC pin and compare your measurements to those printed on the schematic diagram. Make sure that the voltage at VDD pin terminal 42 is 5V. Suspect U3101 if the voltage measured at pin 42 is low. U3101 must be replaced if the voltage is extremely low at pin 42. Replace U3101 with the manufacturer's exact replacement, part number 206889 (CTC167).

Scan-derived low voltage problems

In some of these sets, the isolation or fusible resistor found in the flyback low voltage circuits has opened up and caused a few low-voltage problems. A quick low-ohm resistor test across each resistor can determine if the resistor is open or overheated. If resistor R4701 (10Ω) is open, that might indicate problems within the color output transistor circuits of Q5001, Q5001, or Q5003.

If the 9V regulator transistor, Q4107 is defective, R4172 (22Ω) might be found burned or open. If you encounter this situation, replace both Q4107 and R4172. Check CR4166 and CR4165 in the base circuit of Q4107 for possible leakage and overheating. Disconnect one end of each diode to insure a correct diode test. If you find that any of those components are defective and replace them, then find that the voltage from the +9V source is low, replace electrolytic capacitor C2714 (150μF).

If R4125 (3.9Ω) resistor in the collector circuit of the +12V run transistor (Q4106) is defective, it might cause the chassis to pulse on and off and then go into shutdown (Figure 8). If Q4106 is found to be open or shorted, check CR4119 for possible leakage. Check resistor R4126 and Q4162 for intermittent shutdown. Also test CR4163 and CR4162 in the same on/off switch circuit for leakage. Replace Q4162 with the original part number (146050), or a suitable universal transistor replacement.

Conclusion

The horizontal and low voltage circuits must function before required voltages can be applied to the various TV circuits. Critical component tests within the low voltage power supply circuits can solve many different service problems within the RCA CTC166 and CTC167 chassis. Intermittent shutdown and pulse off and on symptoms are more difficult to locate and repair. Being aware of the different service problems found in these two chassis might help a technician to place another RCA chassis back

Plasma TV

by Jim Van Laarhoven

It is remarkable that the cathode-ray tube has dominated the television market for such a long period of time. The flat-screen was expected to replace the bulky CRT many years ago, however, it never exactly did. The technology existed, but was said to be cost-prohibitive. In the meantime, TVs became more sophisticated, while the cabinet size remained the same. Laymen would ask you what that protrusion in the back of the TV cabinet was, and you answered; "Why, it's the thing that keeps you from having more space in your living room."

Plasma TV does seem to be coming of age. The prices are dropping and more manufacturers are entering the market to meet the needs of an ever-growing consumer market. This article will cover two such flat-screen models. One made by REVOX and another by Pioneer.

Van Laarhoven is an independent technician and consultant for computer based lighting. Some information for this article was derived from the REVOX website. The PDP505HD was supplied by Pioneer Electronics. Some information for the article and figures was derived from the Pioneer website.

Plasma technology basics

Plasma technology was first invented in 1964 by Bitzer and Slattow at the University of Illinois and later developed by Owens-Illinois Glass for the military and aerospace industry. The basic flat-panel structure incorporates a series of red, green, and blue cells sandwiched between two glass substrates (Figure 1). Neon and xenon gas is then injected between these sealed layers to form a complete plasma display panel (PDP). The fundamental operation of a PDP is achieved by introducing a voltage to the transparent and addressing electrodes, causing the internal gas to ionize. This ionization process produces an emission of ultraviolet radiation, which in turn excites the colored phosphors in each individual plasma display cell. Each cell produces one illuminated pixel. The sequence of events for a single color activation is depicted in Figure 2.

Two styles of plasma TV

Plasma televisions are supplied in two different styles; an all-in-one unit, that houses all of the components (like the Pioneer PDP505HD in Figure 3), and another type that locates the video drivers and power supply separate from the rest of the television set.

Revox manufactures a flat screen, model E-542, that uses remote video drivers and a power supply. This remote system allows the separate plasma monitor to be operated from as far away as 60 feet. Configuring it in this manner permits the monitor to be reduced to a measurement

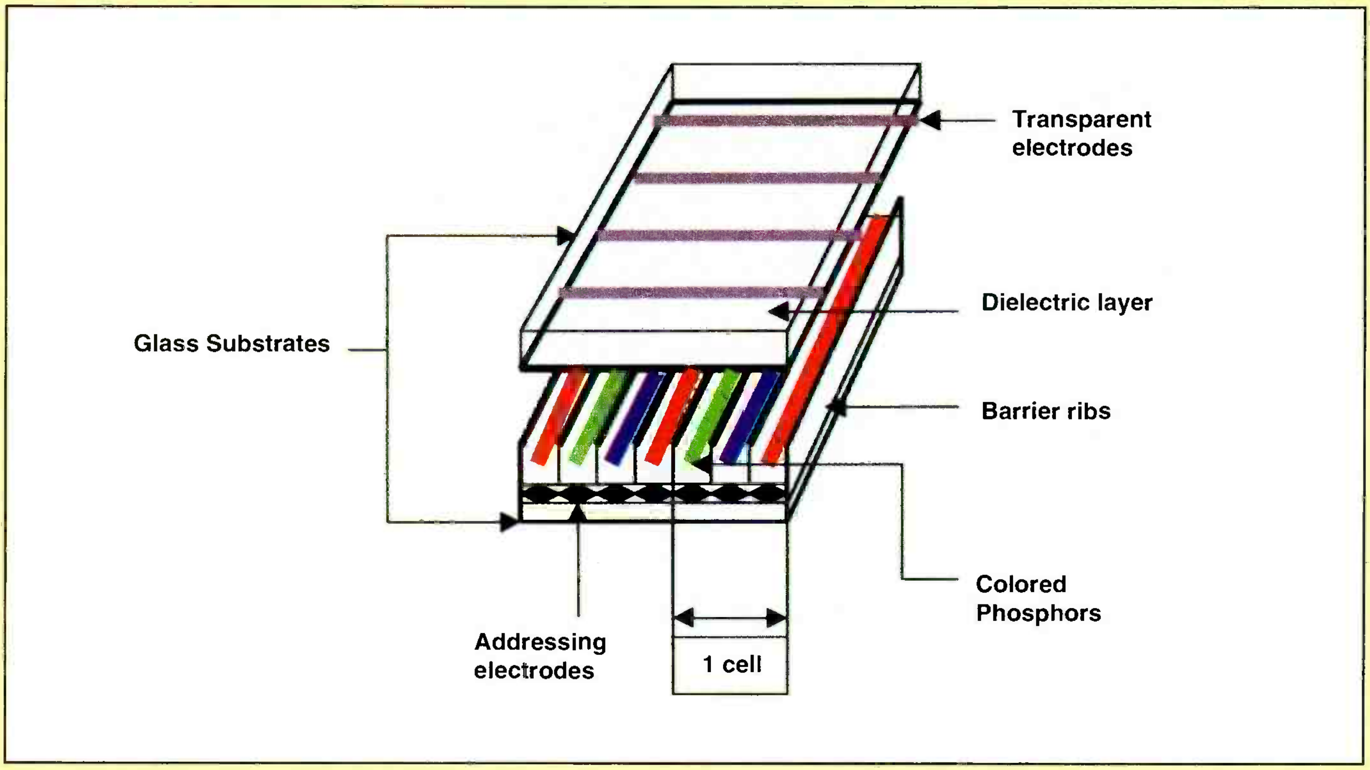


Figure 1. Basic structure of a flat-panel plasma display.

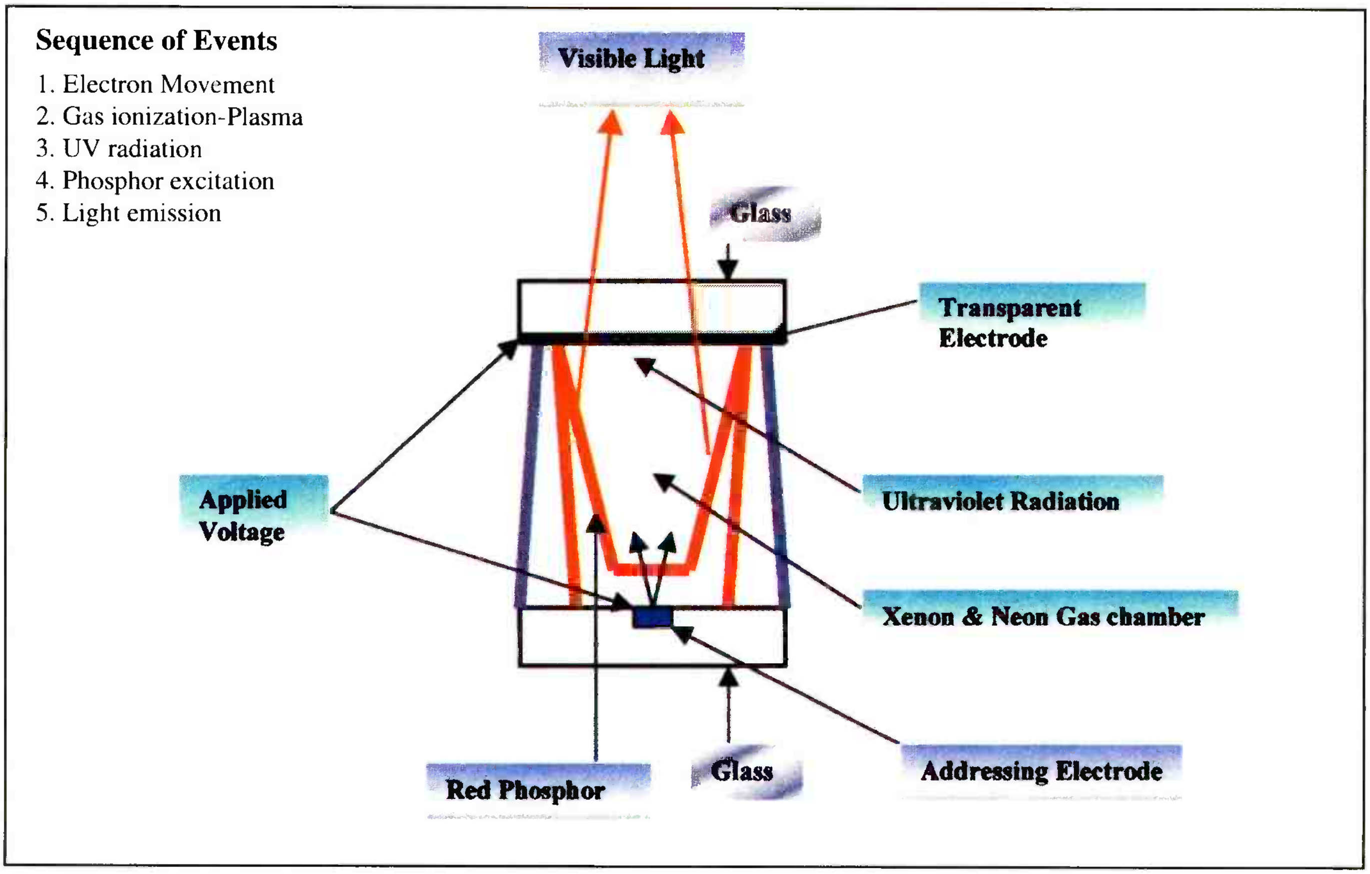


Figure 2. Sequence of events for single color activation.

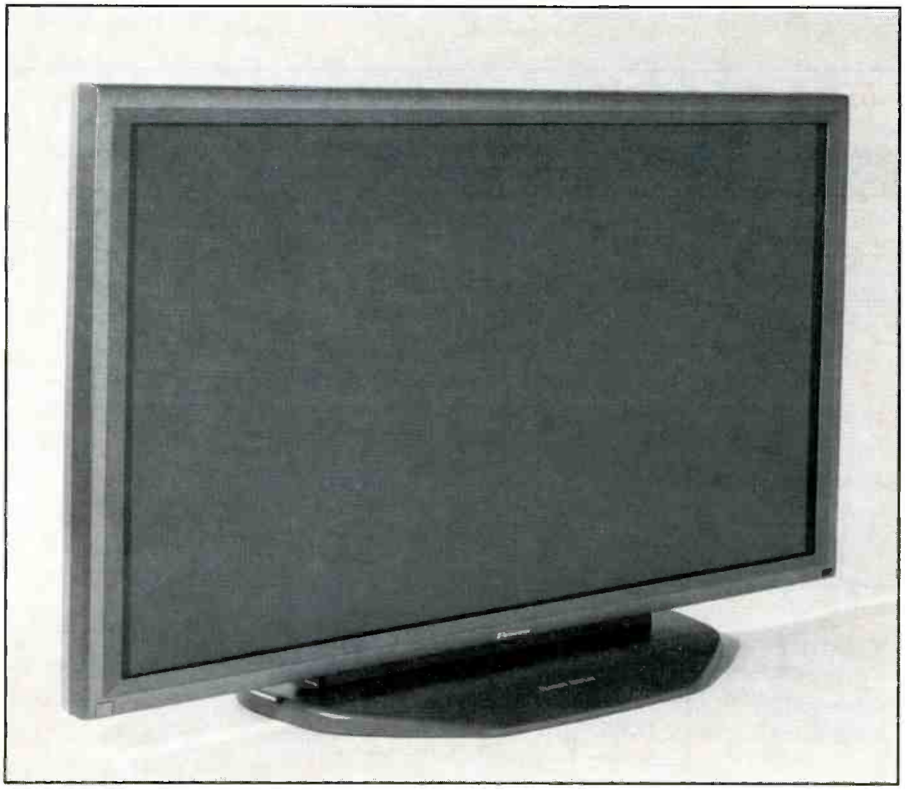


Figure 3. A typical flat-panel display.

of 2-1/4 inches thick, about the size of a large picture frame. This model is capable of upgrading to HDTV when high-definition digital broadcasts become more common. The all-in-one unit in Figure 3 is one of the few plasma TVs that come standard with HDTV capabilities.

Advantages of plasma TV

Focus and illumination qualities seem to be the main advantages of plasma TV (other than size). Since each cell is activated separately, there is no loss of focus. In addition, dark or hot spots have also been eliminated because of plasma's inherent even illumination. Another benefit of the plasma screen is that it is not susceptible to magnetic distortion. Speakers or other magnetically active components have no affect on the quality of the picture.

Considering the high performance video output of the plasma monitor, it will interface well with DVDs, laserdiscs, and even the personal computer. The Pioneer model, PDP-501MX, supports a 1280i x 768i pixel/line image that competes successfully with most computer monitors.

This is the model that we will cover in greater detail throughout the remainder of this article.

The Pioneer PDP501MX plasma TV set

The Pioneer PDP501MX, is a 50-inch plasma display panel with a 16:9 aspect ratio. It provides 256 graduations/16.77 million colors and a maximum brightness of 350 cd/m2 (white peak). It weighs about 94 pounds and is very similar in appearance to the flat screen illustrated in Figure 3. It can be wall, ceiling, or table-top mounted and has a wide variety of input/output controls and connectors (Figure 4).

One of the interesting features included in this set is the screen-saver mode. The unit will detect an extended lack of motion on the plasma screen and automatically dim it to a safer level. When using the screen as a computer monitor, this could be helpful. This feature usually enables itself about 5 minutes after power-up.

Programming of the flat screen's adjustments can be achieved in three different ways: at the operations panel on the right-hand side, with the remote control, or with a PC (using the RS232C control). We will now go briefly through some of these adjustments.

Adjustments to the Pioneer flat-screen TV

This unit has four major operating modes. Normal, which allows setting of the screen-size switching and full auto-zoom. Menu, which is used for setting the picture quality and image positioning. Integrator, which mainly adjusts white balance. RS232C, which enables adjustments by using your PC. Although the unit is preset at the factory, ambient conditions where the set is to be used may require some changes. If at any time the entire process gets out of hand, you can always do a total initialize and the system will go back to the factory presets.

Initialization of the set using the remote

Here is a description of using the remote to perform a simple initialization.

Press the Menu button and 5 items will appear; Picture, White balance, Screen, Additional set-up, and Total Initialize. Move the cursor to total initialize and press Set. It will then ask you the perfunctory: are you sure? Then you move the cursor to yes and press the set button, the menu screen will then return.

The additional set-up function handles baud rates and mirror mode (which allows the picture to basically reverse). The screen function sets the parameters for H.POSI., V.POSI., CLK FRQ., and CLK PHS. The white balance sets the parameters for R HIGH, G HIGH, B HIGH, R LOW, G LOW, and B LOW. The picture function on the menu sets the parameters for Contrast, Bright, Color, Tint, Sharp, and Detail. Again, pressing Total Initialize at any point in the programming will set the unit to the factory presets. Of course, there are many more options than this, especially if you are using your PC to do the programming. This start-up will be all you need to get the picture in the ball-park until you make the fine adjustments you deem necessary.

Installing the plasma TV set

Installing the Pioneer PDP501MX in a location other than on a table-top, requires some structural inspection. When the screen is to be mounted on either a ceiling or a wall, there needs to be some sturdy frame behind the mounting surface. Stud finders, bubble-levels, and careful measurements can reduce the guesswork and make for a cleaner looking finished installation.

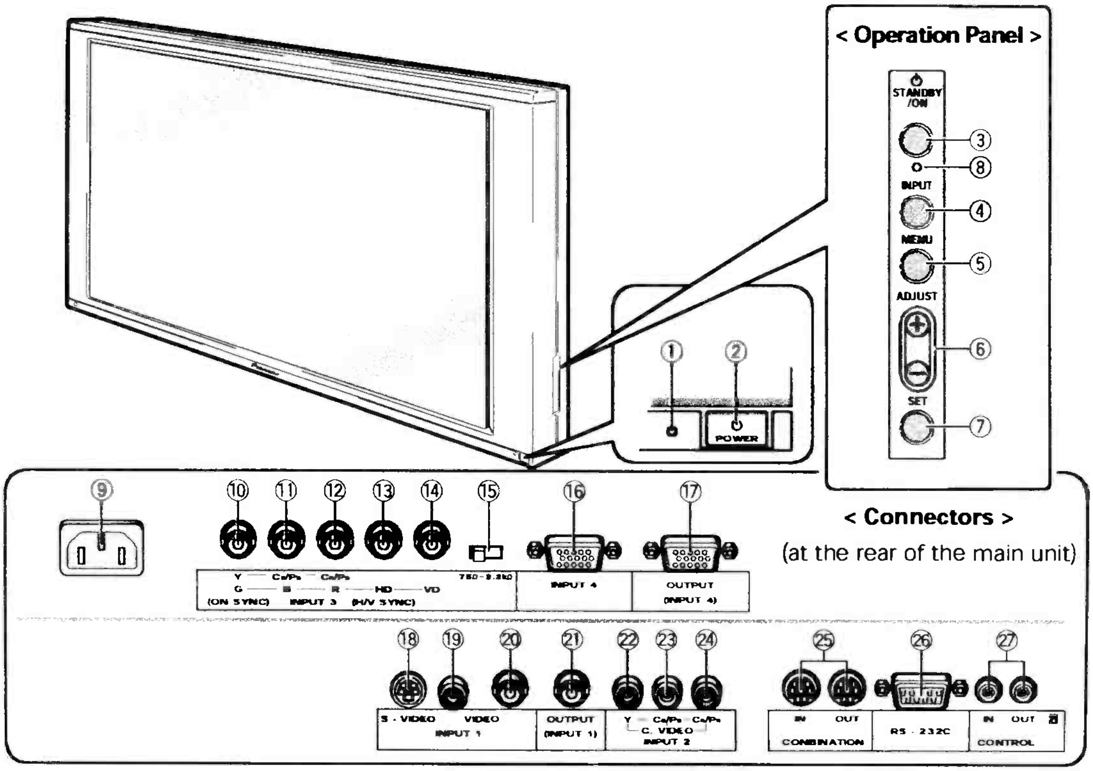
This unit is equipped with 4 variable-speed cooling fans located near the top of the set. In addition, a total of 33 air vents surround the unit. Care should be taken during the planning stages of the install to ensure that these fans and vents have enough clearance for proper airflow.

Some plasma TVs may incur a problem known as pseudo-contour. A pattern of striped shadows may accompany a moving image that contains certain colors or different levels of brightness. Using different video drivers, manufacturers can keep this effect to a minimum.

Maintenance

Maintenance of the plasma TV will be covered only briefly in this article. Some of the same precautions that are taken for CRTs can be applied to the plasma display panel as well. Still images affect the plasma screen the same way they affect a

2.3 Controls and Connectors



< Main Power Switch Section >

① **STANDBY/ON indicator**

Red indicates standby status, green indicates powering on.

② **POWER switch**

Turns main power on or off.

< Control Panel >

③ **Power switch**

Toggles unit on or off (standby).

④ **INPUT switch**

Used to select inputs

⑤ **MENU switch**

Switches the menu screen on or off.

⑥ **ADJUST buttons**

Used to move the cursor on the menu screen or to increment/decrement adjustment values

⑦ **SET button**

Used to select an adjustment item in the menu screen or to change settings

⑧ **KEY LOCK/UNLOCK button (hidden)**

Renders the operation panel and remote operative or inoperative.

< Connectors >

⑨ **AC INLET**

INPUT 3 Inputs

These RGB inputs are composed of five BNC terminals, ⑩ to ⑭. They also support the component video signal (settings required in the menu screen).

⑩ **Green Input: 75Ω**

Receives signals of G, G with sync, and Y.

⑪ **Blue Input: 75Ω**

Receives signals of B, CB, and PB.

⑫ **Red Input: 75Ω**

Receives signals of R, CR, and PR.

⑬ **Horizontal and Composite Sync Signal Input: 75Ω/ 2.2kΩ**

Receives signals of HD, and H/V Sync.

⑭ **Vertical Sync Signal Input: 75Ω/2.2 kΩ**

Receives a VD signal.

⑮ **Sync Signal Input Impedance switch**

Used to switch input impedance for items ⑬ and ⑭ between 75Ω and 2.2 kΩ.

INPUT 4 Input

⑯ INPUT 4 input terminal

Mini D-Sub 15-pin terminal for connection of RGB signals

This terminal also supports component signals (settings required in the menu screen).

This terminal supports Microsoft Plug & Play (VESA DDC 1/2B).

(VESA is a registered trademark of the Video Electronics Standards Association.)

INPUT 4 Output

⑰ INPUT 4 output terminal

Signals fed to the INPUT 4 input terminal ⑯ are sent from this output terminal. No signal is sent when power is switched off, or in standby status.

NOTE: When the unit is connected in a series using this output terminal, up to five units can be connected including the unit to which signals are first input. If you use separate sync or composite sync signal, over 4.8 Vp-p sync level is necessary between the video source and the first unit, under the condition of 2.2 kΩ input impedance.

INPUT 1 Inputs

⑱ S2 Video Input terminal (S terminal)

⑲ Video Input terminal (RCA jack)

⑳ Video Input terminal (BNC terminal)

To prevent malfunctions and breakdowns, avoid connecting the RCA jack and BNC terminal simultaneously, since they are electrically connected to each other inside the body.

INPUT 1 Output

㉑ Video Output terminal

Signals fed to the INPUT 1 Video Input ⑲ or ⑳ are sent from this output terminal. This terminal does not carry signals received at the S-input terminal ⑱. No signal is available at this output terminal when power is switched off, or in standby status.

NOTE: When the unit is connected in a series using this output terminal, up to five units can be connected including the unit to which signals are first input.

INPUT 2 Input

Component video input terminals composed of three RCA jacks ㉒ to ㉔.

㉒ Y Input: 75Ω

㉓ CB and PB Input: 75Ω

㉔ CR and PR Input: 75Ω

Control

㉕ Combination Input and Output terminals

Used for simultaneous control of multiple units (Refer to 5.6 Combination Connections)

NOTE: No ABL linkage function is provided. These terminals are incompatible with multi-projections such as the RM-V4800V.

㉖ Control connector (conforming to RS-232C)

Used to make adjustments or settings externally

㉗ SR IN/OUT terminals

For SR connection (refer to the operation manual) to AV units from Pioneer

NOTE: This product does not support RU-V107 wired remote control units.

Figure 4. Specifications for a 50-inch plasma display set.

CRT screen since phosphors are used in both applications. Blue and green phosphors degrade faster than red, so it is recommended to readjust the white balance every 1000 hours. It should be noted that when programming certain plasma TVs with a PC, the screen-saver function is not activated.

The plasma display screen is generally coated with an anti-glare material that can be easily damaged. While cleaning the screen surface, it is advised to gently wipe the surface with a soft cloth. Most cleaning solutions will discolor the monitor surface, or cause it to become opaque.

As mentioned earlier, some models require forced-air cooling because of the restricted space of the cabinet enclosure. Dirt and dust should be removed monthly from the vents to reduce the internal temperature. Certain manufacturers recommend using a low suction vacuum cleaner with a brush attachment for debris removal.

The future of flat screens

The idea of flat screens totally replacing CRTs is a progressive one. The applications remind us of so many possibilities. Anything that uses a CRT could be reduced in weight and size. Testing equipment that used to be too bulky to be transported easily or safely, could be carried anywhere. Display panels could be hung on walls like pictures throughout a house to monitor or control environment and entertainment, or whatever the imaginative mind can conceive. It may be awhile before these ideas become commonplace, nevertheless, with the progression of technology, they will be inevitable. ■

What Do You Know About Electronics?

by J.A. "Sam" Wilson

General-case equations

A general-case equation can be used to find the value of an unknown in a network when various values are assigned to a resistor in the network. For this article, we will write a general-case equation for the total current (I_T) when the value of the series resistor is known for several values.

Refer to Figure 1. The total current, I_T, is:

$$I_T = \frac{V}{R_S + \left(\frac{R_2R_3}{R_2 + R_3}\right)}$$

$$= \frac{12}{R_S + 12}$$

Observe that for every value of R_S, there is a corresponding value for I_T. For example, if $R_S = 12$, $I_T = 0.5A$.

Also, as R_S approaches the value of 0Ω, the value of I_T approaches 12/12, or 1A. That is the maximum value for the total current. Mathematicians write that as

$$\lim_{R_S \to 0} \frac{12}{R_S + 12} = 1$$

This equation is read as:

The limit as R_S approaches 0 of $\frac{12}{R_S + 12}$ is one.

In the circuit, R_S can be called a limiting resistor. It can be used to prevent an excessive battery current. In most cases, a single resistor, not a parallel branch, can be used for a limiting resistor. An example is shown in Figure 2.

Resistor R_2 in Figure 2 is usually referred to as a surge-limiting resistor. When the switch is closed, the ac power is applied

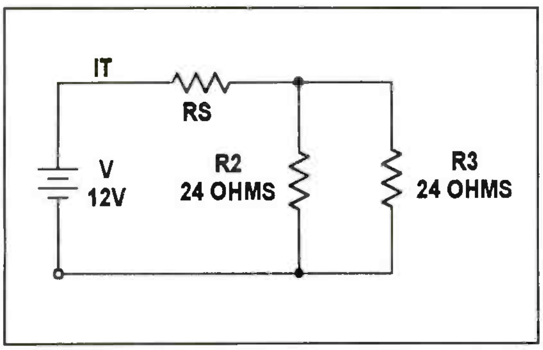


Figure 1. An equation can be written to solve for an unknown value in this circuit.

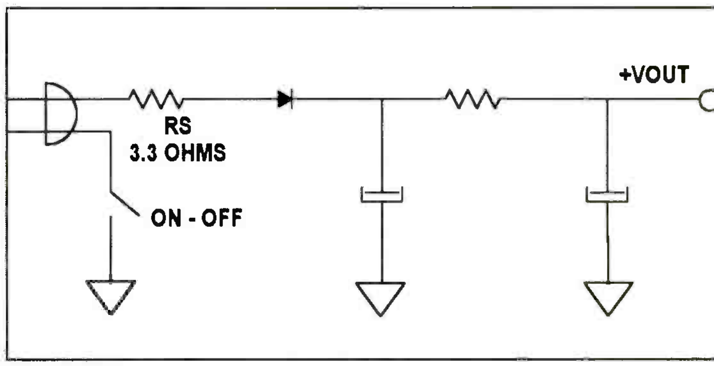


Figure 2. A single resistor can be used to limit the current.

to the circuit. On the first positive half-cycle, delivered to the anode of the diode, a very high charging current flows into and out of the electrolytic capacitors and through the diode. Without the limiting resistor, the diode could be destroyed.

Although the value of the limiting resistor is only 3.2Ω, the high capacitor charging current produces a higher voltage across it. That high voltage limits the current through the diode while the capacitors are charging.

If you run across a case in which R_S has been destroyed, after you replace it, don't turn the power on to the unit until you check the power supply output circuit. A short circuit in that supply output can easily destroy R_S.

It is a good idea to keep in mind the fact that there are only three uses of resistors in a circuit:

- limit current,
- produce a voltage drop,
- produce heat (as in a stove).

Technicians can forget that when they encounter the wide variety of names they are given in circuits. Examples of the many names given to resistors are:

- surge-limiter,
- swamping resistor,
- impedance matching resistor,
- load resistor,
- equivalent series resistor.

A true story about uses of resistors

Please let me tell you a true story. I may have told it to you before, but it is one of my favorites, so I'd like to hear it again.

I was invited to lecture on this subject in a very colorful state. I was introduced to an audience of technicians. I stood up to the

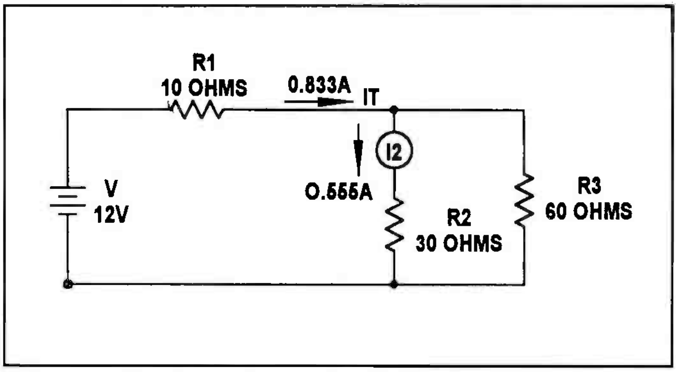


Figure 3. According to the reciprocity theorem, the current source, and the voltage source in this circuit can be interchanged.

podium, but before I could say one word, a man got up in the front row, turned to the audience and said, "who invited this guy here and who is going to pay for it?" After the resulting argument, I was feeling lower than a snake's belly in a wagon rut. The ensuing lecture was a flop, and I think I went home in the cargo hold of a very small airplane.

The thing that brought that story to mind is that a technician came up to me after the lecture and said, "resistors are also used as coil forms." He was thinking of peaking coils used in RF amplifier circuits. I'm still not sure that that should be listed as one of the uses of resistors.

The reciprocity theorem

In a circuit with one voltage source (such as the circuit in Figure 1), and a network comprised of linear bilateral circuit elements (resistors, for example), the current and the voltage source can be interchanged and there will be no loss of current in the process. Let's try that out in the circuit of Figure 3. First we will find the total current, I_T.

$$I_T = \frac{V}{R_1 + \frac{R_2R_3}{R_2 + R_3}}$$

$$= \frac{25}{10 + \frac{30 \times 60}{30 + 60}}$$

$$= \frac{25}{10 + 20} = 0.833$$

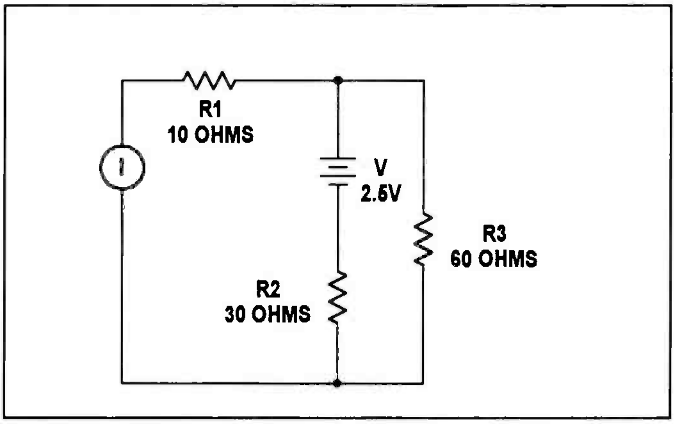


Figure 4. This is the circuit of Figure 3 with the current source and the voltage source interchanged.

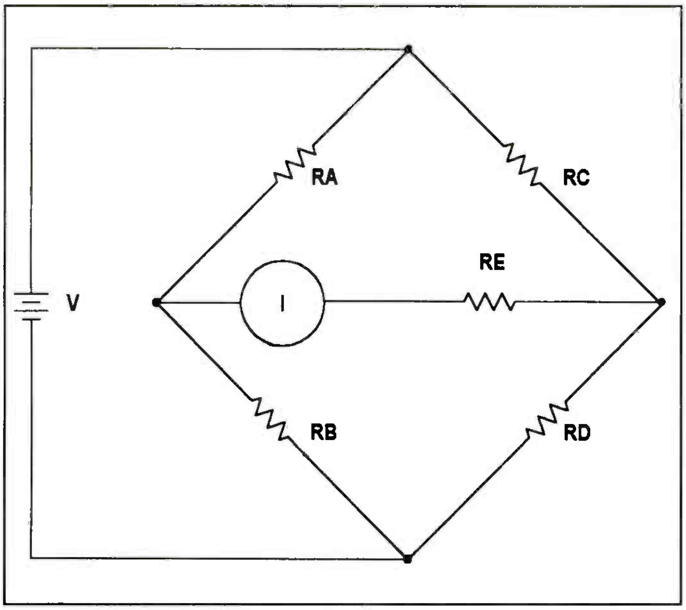


Figure 5. The reciprocity theorem can be used to find the value of current in the center leg of a Wheatstone bridge.

By the reciprocal method,

$$I_2 = I_T \left(\frac{R_3}{R_2 + R_3} \right)$$

$$= 0.833 \left(\frac{60}{30 + 60} \right)$$

$$= 0.555.A$$

Figure 4 shows the circuit with the battery and current source interchanged and we will calculate the current through the 10Ω resistor. The total current is now

$$I_T = \frac{V}{R_2 + \frac{R_1 R_3}{R_1 + R_3}}$$

$$= \frac{25}{30 + \frac{10 \times 60}{10 + 60}}$$

$$= \frac{25}{30 + \frac{600}{70}}$$

$$= \frac{25}{38.57}$$

$$= 0.648 \text{ A}$$

By the reciprocal method,

$$I = 0.648 \times 60/70$$
$$= 0.555A$$

You can carry the multiplications and divisions out to more decimal places to show that the reciprocity theorem is valid.

An interesting application is finding the value of the current in the center leg of a Wheatstone bridge. See Figures 5 and 6.

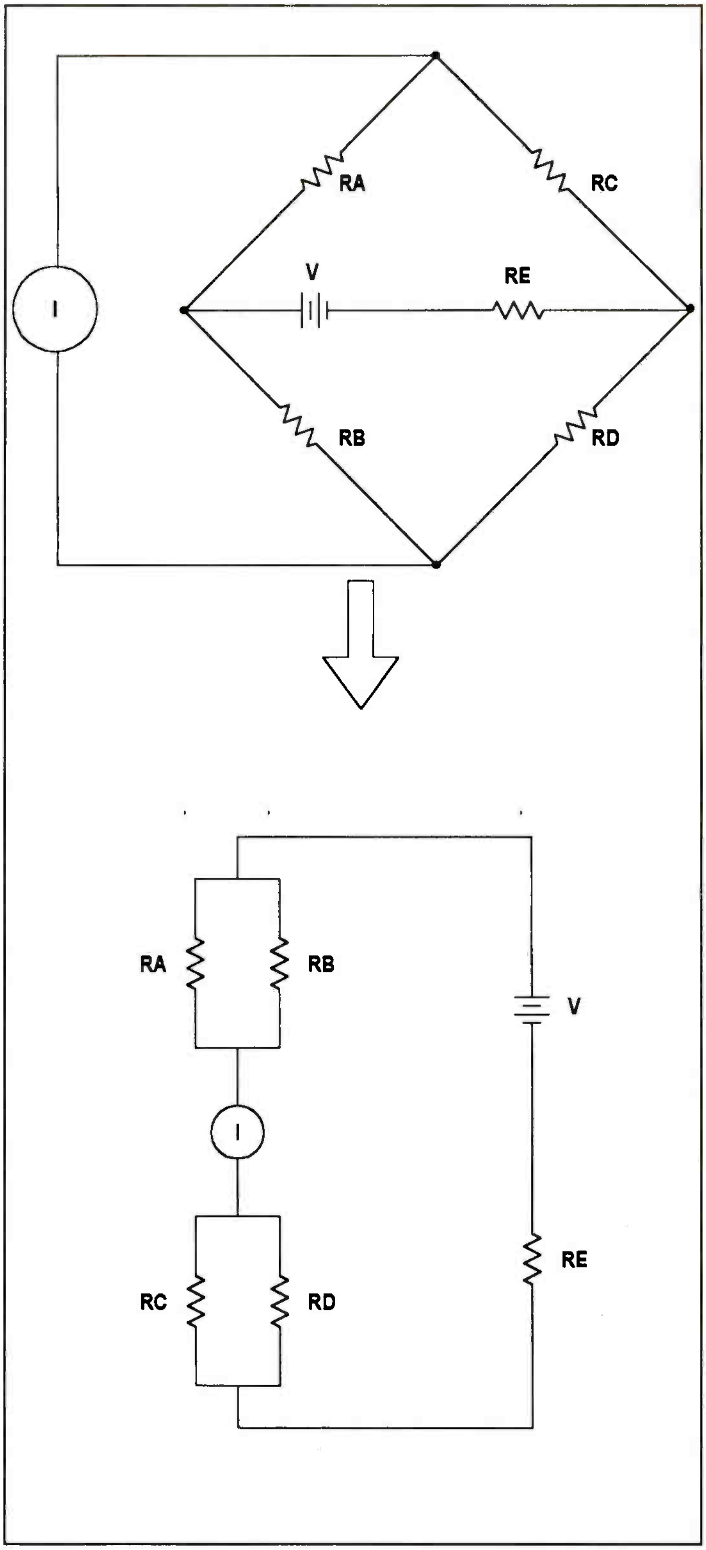


Figure 6. This graphic shows the process for using the reciprocity theorem to find the current in the center leg of a Wheatstone bridge.

This problem has been discussed in this department before. Observe that the circuit is much easier to solve after the battery and current are interchanged.

Here is a mystery: why isn't the reciprocity theorem used more often in text books?

One possible answer: it makes the circuit too easy to solve. ■

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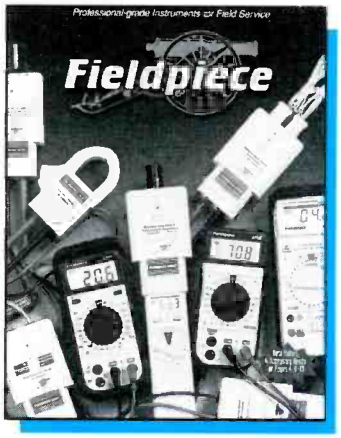

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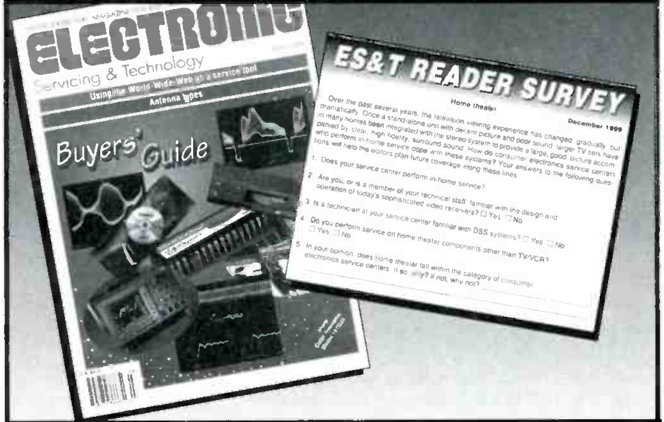

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