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Sci.Electronics FAQ: Repair: TV Repair Notes on TV Repair and Diagnosis INDEX V2.20 (3/26/96) Table of Contents Chapter 1) About the Author & Copyright Chapter 2) Introduction 2.1) Television at the crossroads 2.2) Television receiver fundamentals 2.3) TV repair 2.4) Repair or replace Chapter 3) TV Receivers 101 3.1) Subsystems of a television set 3.2) For more information on TV technology Chapter 4) CRT Basics 4.1) Color CRTs, Shadowmasks, Magnetic Fields, and Degauss 4.2) Why is the Shadowmask or Aperture Grill made of a magnetic material? 4.3) Tubes for all Nations 4.4) Degaussing (demagnetizing) a CRT 4.5) Why are indirectly heated cathodes used in CRT 4.6) Why do TVs overscan? 4.7) Scratches in CRT face Chapter 5) TV Placement and Preventive Maintenance 5.1) General TV placement considerations 5.2) Preventive maintenance Chapter 6) TV Troubleshooting 6.1) Safety 6.2) Safety Guidelines 6.3) Troubleshooting tips 6.4) Test equipment 6.5) Incredibly Handy widgets 6.6) Safe discharging of capacitors in TVs and video monitors 6.7) The series light bulb trick 6.8) Getting inside a TV 6.9) Dusting out the inside of a TV Chapter 7) TV Adjustments 7.1) User picture adjustment 7.2) Focus adjustment 7.3) Adjustment of the internal SCREEN and color controls 7.4) Color Balance 7.5) Horizontal position, size, and linearity adjustment 7.6) Vertical position, size, and linearity adjustment 7.7) Pincushion adjustments 7.8) Geometry adjustment 7.9) Why is the convergence on my set bad near the edges 7.10) CRT purity and convergence problem 7.11) CRT purity adjustment 7.12) CRT convergence adjustment 7.13) Tilted picture Chapter 8) Low Voltage Power Supply Problems 8.1) Low voltage power supply fundamentals 8.2) Power button on set is flakey 8.3) TV blows fuse 8.4) Internal fuse blew during lightening storm (or elephant hit power pole) 8.5) Fuse replaced but TV clicks with power-on but no other action 8.6) Power-on tick-tick-tick or click-click-click but no other action 8.7) No picture or raster and no sound 8.8) Reduced width picture and/or hum bars in picture and/or hum in sound 8.9) TV power cycling on and off 8.10) Dead TV with periodic tweet-tweet-tweet or flub-flub-flub 8.11) Shorted Components 8.12) Startup problems - nothing happens, click, or tick-tick-tick sound 8.13) TV turns off after warming up 8.14) TV doesn't power up immediately 8.15) Old TV requires warmup period 8.16) Relays in the Power Circuitry of TVs 8.17) Flameproof Resistors Chapter 9) Deflection Problems 9.1) Deflection fundamentals 9.2) Why are nearly all horizontal drivers circuits transformer coupled? 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Goldwasser E-Mail: Copyright (c) 1994, 1995, 1996 All Rights Reserved Reproduction of this document in whole or in part is permitted if both of the following conditions are satisfied: This notice is included in its entirety at the beginning. There is no charge except to cover the costs of copying. Chapter 2) 2.1) Introduction Television at the crossroads Television in substantially its present form has been with us for nearly 50 years. It is a tribute to the National Television Standards Committee (NTSC) that the color television standards agreed upon in the early 1950s have performed remarkably well making quite efficient use of valuable radio spectrum space and the psychovisual characteristics of the human eye-brain system. However, HDTV (High Definition TV) will supplant and ultimately replace the current standards. We will all come to expect its superior resolution, freedom from noise and ghosting, and CD sound. Yet, the perceived quality of TV broadcasts and cable will never likely be the major issue with most consumers. Content will continue to be the biggest problem. It is likely that in roughly 15 years, HDTV - digitally processed and transmitted as 1s and 0s - will completely replace the current system. Acceptance in the marketplace is by no means assured but with the merging of TV and computers - with the Internet as a driving force - it would seem that the days of the stand-alone analog TV set are numbered. 2.2) Television receiver fundamentals The basic color television receiver must perform the same functions today as 40 years ago. (Since B/W is a subset of the color standard, most references in this document will be for color except as noted). A studio video monitor includes all of the functions of a television receiver except the tuner and IF (which rarely fail except for bad connections or perhaps lightening strikes to the antenna or cable connection). Therefore most of the repair information in this document is applicable to both TVs and studio monitors. Modern computer monitors share many similarities with TVs but the multisync and high scan rate deflection circuitry and more sophisticated power supplies complicates their servicing. As of this writing, all but the smallest TVs are based on the Cathode Ray Tube (CRT) as the display device. Tiny pocket sets, camcorder viewfinders, and the like have started using LCD (Liquid Crystal Display) panels but these are still inferior to the CRT for real time video. There has always been talk of 'the picture on the wall' display. While we are closer than ever to this possibility, I believe that mass production of an affordable wall mural TV screen is still decades away. The reason is simple economics - it is really hard to beat the simplicity of the shadowmask CRT. For example, a decent quality active matrix color LCD panel may add $1000 to the cost of a notebook computer compared to $200 for a VGA monitor. More of these panels go in the dumpster than make it to product do to manufacturing imperfections. Projection - large screen - TVs may, on the other hand, be able to take advantage of a novel development in integrated micromachining - the Texas Instruments Inc. Digital Micromirror Device (DMD). This is basically an integrated circuit with a tiltable micromirror for each pixel fabricated on top of a static memory - RAM - cell. This technology would permit nearly any size projection display to be produced and would therefore be applicable to HDTV. Since it is a reflective device, the light source can be as bright as needed. However, this is still not a commercial product but stay tuned. 2.3) TV repair Unlike VCRs or CD players where any disasters are likely to only affect your pocketbook, TVs can be dangerous. Read, understand, and follow the set of safety guidelines provided later in this section whenever working on TVs, monitors, or other similar high voltage equipment. If you do go inside, beware: line voltage (on large caps) and high voltage (on CRT) for long after the plug is pulled. There is the added danger of CRT implosion for carelessly dropped tools and often sharp sheetmetal shields which can injure if you should have a reflex reaction upon touching something you should not touch. In inside of a TV or monitor is no place for the careless or naive. Having said that, a basic knowledge of how a TV set works and what can go wrong can be of great value even if you do not attempt the repair yourself. It will enable you to intelligently deal with the service technician. You will be more likely to be able to recognize if you are being taken for a ride by a dishonest or just plain incompetent repair center. For example, a faulty picture tube CANNOT be the cause of a color television only displaying shows in black-and-white. The majority of consumers probably do not know even this simple fact. Such a problem is usually due to a bad capacitor or other 10 cent part. This document will provide you with the knowledge to deal with a large percentage of the problems you are likely to encounter with your TVs. It will enable you to diagnose problems and in many cases, correct them as well. With minor exceptions, specific manufacturers and models will not be covered as there are so many variations that such a treatment would require a huge and very detailed text. Rather, the most common problems will be addressed and enough basic principles of operation will be provided to enable you to narrow the problem down and likely determine a course of action for repair. In many cases, you will be able to do what is required for a fraction of the cost that would be charged by a repair center. Should you still not be able to find a solution, you will have learned a great deal and be able to ask appropriate questions and supply relevant information if you decide to post to sci.electronics.repair. It will also be easier to do further research using a repair text such as the ones listed at the end of this document. In any case, you will have the satisfaction of knowing you did as much as you could before taking it in for professional repair. With your new-found knowledge, you will have the upper hand and will not easily be snowed by a dishonest or incompetent technician. 2.4) Repair or replace If you need to send or take the TV to a service center, the repair could easily exceed half the cost of a new TV. Service centers may charge up to $50 or more for providing an initial estimate of repair costs but this will usually be credited toward the total cost of the repair (of course, they may just jack this up to compensate for their bench time). TV prices have been dropping almost as fast as PC prices. Therefore, paying such prices for repair just may not make sense. Except for picture tube problems, most TV faults can be corrected without expensive parts, however. Keeping a 5 year old TV alive may be well worthwhile as basic TV performance and important features have not changed in a long time. If you can do the repairs yourself, the equation changes dramatically as your parts costs will be 1/2 to 1/4 of what a professional will charge and of course your time is free. The educational aspects may also be appealing. You will learn a lot in the process. Thus, it may make sense to repair that old clunker for your game room or beach house. (I would suggest the kid's room but most TV watching just rots the brain anyhow so a broken TV may be more worthwhile educationally than one that works.) Chapter 3) 3.1) TV Receivers 101 Subsystems of a television set A TV set includes the following functional blocks: Low voltage power supply (some may also be part of (2)). Most of the lower voltages used in the TV may be derived from the horizontal deflection circuits. Sometimes, there is a separate switching power supply but this would be the exception. Rectifier/filter capacitor/regulator from AC line provides the B+ to the switching power supply or horizontal deflection system. Degauss operates off of the line whenever power is turned on (after having been off for a few minutes) to demagnetize the CRT. Horizontal deflection. These circuits provide the waveforms needed to sweep the electron beam in the CRT across and back some 15,734 times per second (for NTSC). The horizontal sync pulse from the sync separator locks the horizontal deflection to the video signal. Vertical deflection. These circuits provide the waveforms needed to sweep the electron beam in the CRT from top to bottom and back 60 times per second (for NTSC). The vertical sync pulse from the sync separator locks the vertical deflection to the video signal. CRT high voltage (also part of (2)). A modern color CRT requires up to 30 KV for a crisp bright picture. Rather than having a totally separate power supply, nearly every TV on the planet derives the HV (as well as many other voltages) from the horizontal deflection using a special transformer called a 'flyback' or 'Line OutPut Transformer (LOPT) for those of you on the other side of the lake. Tuner, IF, AGC, video and audio demodulators. Input is the antenna or cable signal and output are baseband video and audio signals. There is usually someplace inside the TV where line level video and audio are present but it may not be accessible from the outside of the cabinet unless you paid for the more expensive model with the A/V option. Very often, the tuner is a shielded metal box positioned on the bottom right (as viewed from the front) separate from the main circuit board. Sometimes it is on the main circuit board. The IF section may be in either place. On older or cheap TVs with a knob tuner, this is usually mounted to the front panel by itself. There are usually separate boxes for the VHF and UHF tuners. Chroma demodulator. Input is the baseband video signal. Outputs are the individual signals for the red, green, and blue video to the CRT. Video drivers (RGB). These are almost always located on a little circuit board plugged directly onto the neck of the CRT. They boost the output of the chroma demodulator to the hundred volts or so needed to drive the cathodes of the CRT. Sync separator. Input is baseband video. Output is horizontal and vertical sync pulses to control the deflection circuits. Audio amplifier/output. The line level audio is amplified to drive a set of speakers. If this is a stereo TV, then these circuits must also perform the stereo demultiplexing. System control. Most modern TVs actually use program microcomputer to perform all user from the front panel and remote control. sophisticated. However, they do not fail of knobs and switches and these are prone a microcontroller - a fixed interface and control functions These are becoming increasingly often. Older TVs use a bunch to wear and dirt. Most problems occur in the horizontal deflection and power supply sections. These run at relatively high power levels and some components run hot. The high voltage section is prone to breakdown and arcing as a result of hairline cracks, humidity, dirt, etc. The tuner components are usually quite reliable unless the antenna experiences a lightening strike. However, it seems that even after 20+ years of solid state TVs, manufacturers still cannot reliably solder the tuner connectors and shields so that bad solder connections in these areas are common even in new sets. 3.2) For more information on TV technology The books listed in the section: Suggested references include additional information on the theory and implementation of the technology of television standards and TV receivers. For an on line introduction to TV and monitor technology, point your web browser to the Magnavox reference page at the following URL: There you will find links to a number of articles on the basic principles of operation of CD players, laserdisc and optical drives, TVs, VCRs, camcorders, loudspeakers, satellite receivers, and other consumer A/V equipment. Chapter 4) 4.1) CRT Basics Color CRTs, Shadowmasks, Magnetic Fields, and Degauss All color CRTs utilize a shadowmask or aperture grill a fraction of an inch (1/2 typical) behind the phosphor screen to direct the electron beams for the red, green, and blue video signals to the proper phosphor dots. Since the electron beams for the R, G, and B phosphors originate from slightly different positions (individual electron guns for each) and thus arrive at slightly different angles, only the proper phosphors are excited when the purity is properly adjusted and the necessary magnetic field free region is maintained inside the CRT. Note that purity determines that the correct video signal excites the proper color while convergence determines the geometric alignment of the 3 colors. Both are affected by magnetic fields. Bad purity results in mottled or incorrect colors. Bad convergence results in color fringing at edges of characters or graphics. The shadowmask consists of a thin steel or InVar (a ferrous alloy) with a fine array of holes - one for each trio of phosphor dots - positioned about 1/2 inch behind the surface of the phosphor screen. With most CRTs, the phosphors are arranged in triangular formations called triads with each of the color dots at the apex of the triangle. With many TVs and some monitors, they are arranged as vertical slots with the phosphors for the 3 colors next to one another. An aperture grille, used exclusively in Sony Trinitrons (and now their clones as well), replaces the shadowmask with an array of finely tensioned vertical wires. Along with other characteristics of the aperture grille approach, this permits a somewhat higher possible brightness to be achieved and is more immune to other problems like line induced moire and purity changes due to local heating causing distortion of the shadowmask. However, there are some disadvantages of the aperture grille design: weight - a heavy support structure must be provided for the tensioned wires (like a piano frame). price (proportional to weight). always a cylindrical screen (this may be considered an advantage depending on your preference. visible stabilizing wires which may be objectionable or unacceptable for certain applications. Apparently, there is no known way around the need to keep the fine wires from vibrating or changing position due to mechanical shock in high resolution tubes and thus all Trinitron monitors require 1, 2, or 3 stabilizing wires (depending on tube size) across the screen which can be see as very fine lines on bright images. Some people find these wires to be objectionable and for some critical applications, they may be unacceptable (e.g., medical diagnosis). 4.2) Why is the Shadowmask or Aperture Grill made of a magnetic material? (From: Jeroen Stessen, ()) The question often arises: Well, if magnetization and the need for degauss is a problem, why not make the shadowmask or aperture grille from something that is non-magnetic? The shadowmask MUST be made of magnetic material! This may seem to be undesirable or counterintuitive but read on: Together with the internal shielding hood it forms sort of a closed space in which it is attempted to achieve a field-free space. The purpose of degaussing is NOT to demagnetize the metal, but to create a magnetization that compensates for the earth's magnetic field. The SUM of the two fields must be near zero! Degaussing coils create a strong alternating magnetic field that gradually decays to zero. The effect is that the present earth magnetic field is frozen into the magnetic shielding and the field inside the shielding will be (almost) zero. Non-zero field will cause colour purity errors. Now you will understand why a CRT must be degaussed again after it has been moved relative to the earth's magnetic field. This will also explain why expensive computer monitors on a swivel pedestal have a manual degaussing button, you must press it every time after you have rotated the monitor. The axial component of the magnetic field is harder to compensate by means of degaussing. Better compensation may be achieved by means of a rotation coil (around the neck or around the screen), this requires an adjustment that depends on local magnetic field. CRT's for moving vehicles (like military airplanes) may be equipped with 6 coils to achieve zero magnetic field in all directions. They use magnetic field sensors and active compensation, thus they don't need any degaussing function. This is too expensive for consumer equipment. 4.3) Tubes for all Nations (From: Jeroen Stessen, ()) CRT Manufacturers actually make different versions of their tubes for TV's for the northern and southern hemisphere, and sometimes a 3rd neutral type. These are so-to-say precorrected for the uncompensated field. (Note that the term 'tube' here includes much of the convergence hardware as well - not just what is inside the glass.) I remember when we exported projection televisions from Belgium to Australia, a couple of years ago. They all had to be opened on arrival to re-adjust the rotation settings on the convergence panel, due to the different magnetic field in Australia. Projection TV's don't have degaussing (there is nothing to degauss), and the customer can only adjust red and blue shift, not rotation. Our CRT application group has a magnetic cage. This is a wooden cube (approx. 2 meter long sides) with copper coils around each of the 6 surfaces. With this they can simulate the earth magnetic field for every place on earth (as indicated on a map on the wall). 4.4) Degaussing (demagnetizing) a CRT Degaussing may be required if there are color purity problems with the display. On rare occasions, there may be geometric distortion caused by magnetic fields as well without color problems. The CRT can get magnetized: If the TV or monitor is moved or even just rotated. If there has been a lightening strike nearby. A friend of mine had a lightening strike near his house which produced all of the effects of the EMP from a nuclear bomb. If a permanent magnet was brought near the screen (e.g., kid's magnet or megawatt stereo speakers). If some piece of electrical or electronic equipment with unshielded magnetic fields is in the vicinity of the TV or monitor. Degaussing should be the first thing attempted whenever color purity problems are detected. As noted below, first try the internal degauss circuits of the TV or monitor by power cycling a few times (on for a minute, off for 30 minutes, on for a minute, etc.) If this does not help or does not completely cure the problem, then you can try manually degaussing. Commercial CRT Degaussers are available from parts distributors like MCM Electronics and consist of a hundred or so turns of magnet wire in a 6-12 inch coil. They include a line cord and momentary switch. You flip on the switch, and bring the coil to within several inches of the screen face. Then you slowly draw the center of the coil toward one edge of the screen and trace the perimeter of the screen face. Then return to the original position of the coil being flat against the center of the screen. Next, slowly decrease the field to zero by backing straight up across the room as you hold the coil. When you are farther than 5 feet away you can release the line switch. The key word here is SLOW. Go too fast and you will freeze the instantaneous intensity of the 50/60 Hz AC magnetic field variation into the ferrous components of the CRT and may make the problem worse. It looks really cool to do this while the CRT is powered. love the color effects. The kids will Bulk tape erasers, tape head degaussers, open frame transformers, and the ass-end of a weller soldering gun can be used as CRT demagnetizers but it just takes a little longer. (Be careful not to scratch the screen face with anything sharp.) It is imperative to have the CRT running when using these whimpier approaches, so that you can see where there are still impurities. Never release the power switch until you're 4 or 5 feet away from the screen or you'll have to start over. I've never known of anything being damaged by excess manual degaussing though I would recommend keeping really powerful bulk tape erasers turned degaussers a couple of inches from the CRT. If an AC degaussing coil or substitute is unavailable, I have even done degaussed with a permanent magnet but this is not recommended since it is more likely to make the problem worse than better. However, if the display is unusable as is, then using a small magnet can do no harm. (Don't use a 20 pound speaker or magnetron magnet as you may rip the shadowmask right out of the CRT - well at least distort it beyond repair. What I have in mind is something about as powerful as a refrigerator magnet.) Keep degaussing fields away from magnetic media. It is a good idea to avoid degaussing in a room with floppies or back-up tapes. When removing media from a room remember to check desk drawers and manuals for stray floppies, too. It is unlikely that you could actually affect magnetic media but better safe than sorry. Of the devices mentioned above, only a bulk eraser or strong permanent magnet are likely to have any effect - and then only when at extremely close range (direct contact with media container). All color CRTs include a built-in degaussing coil wrapped around the perimeter of the CRT face. These are activated each time the CRT is powered up cold by a 3 terminal thermister device or other control circuitry. This is why it is often suggested that color purity problems may go away in a few days. It isn't a matter of time; it's the number of cold power ups that causes it. It takes about 15 minutes of the power being off for each cool down cycle. These built-in coils with thermal control are never as effective as external coils. 4.5) Why are indirectly heated cathodes used in CRT Here are three reasons: The cathode can be made of and/or coated with a material optimal for emitting electrons without regard to its performance as a heater. The separate cathode and filament can be electrically isolated so that the filament voltage and cathode drive signal, if any, do not interfere. The cathode can have an optimal shape for the application. This would be particularly significant for CRTs. The spot on the screen is a reduced focused image of the effective shape of the emitting portion of the cathode. 4.6) Why do TVs overscan? (The following includes material from: Jeroen Stessen ()) Q: TVs are always set up to generate a picture which is 10-15 percent large than the visible face of the CRT. Why? In the early days of TV, this was probably done to make the design easier. Component tolerances and power line voltage fluctuations would be masked even if they caused changes in picture size. There certainly is almost no reason today to have any more than a couple of percent overscan. Most modern TVs have very well regulated power supplies and component values do not really drift much. Computer monitors, for example, are usually set up for no overscan at all so that the entire image is visible. We are constantly reminded of that, now that we are building TV's with VGA inputs (PD5029C1 in the USA, US$ 2000). This mixed application has overscan in TV mode and underscan in VGA mode. Geometry adjustment is quite critical if you see border-on-border. Unfortunately, TV's may be good but VCR's certainly are not. If you have too little overscan and then put the VCR in any feature mode (like picture search) then one (black) picture edge may become visible. Bad form. Viewers do not like this. While design considerations may have been the original reason for overscan, now it has become accepted as a defacto standard, and broadcasters are counting on the overscan being a certain percentage. One wonders whether it will ever change or whether this really matters. I suppose when we have true flat panel digitally addressed displays, we might have 0% overscan. At the Japan Electronics Show all the signs are pointed toward flat panel displays so maybe I will not have to hold your breath for much longer. Physically, as with an LCD display on a laptop computer, there will be 0% overscan (no need to build the extra pixels) but that doesn't mean that all 480 lines will be visible. 4.7) Scratches in CRT face Minor scratches can be removed with Jeweler's rouge or similar ultra fine abrasive. Jeweler's Rouge is the same stuff that is used in the final polishing of lenses and mirrors so it makes for a fine finish. However, any kind of scratch deep enough to be felt will not yield to this approach. WARNING: any kind of deep scratch on a CRT should be considered a serious safety hazard. This may be even more of a concern for modern CRTs that have 'integral implosion protection' - that steel band around the outside'. Older CRTs used either (1) a separate safety shield - that laminated glass plate in front of your grandmom's TV - or (2) a second contoured glass panel bonded to the actual tube face. In both of these cases, the second panel is strictly protective and serves no structural purpose. Therefore, any damage to it does not compromise the tube in any way. In the case of modern CRTs, the steel band in conjunction with the basic tube envelope is used to maintain the integrity of the overall CRT. Any damage significantly decreases the strength and increases the risk of CRT implosion. BTW, scratches in the CRT have absolutely no effect on X-ray emission. X-rays are blocked long before they come anywhere near the surface and glass has very little effect on their direction. Any scratch deep enough to have any detectable effect on X-ray emission (actually, it would need to be an inch deep gouge) would have caused the tube to implode. Chapter 5) 5.1) TV Placement and Preventive Maintenance General TV placement considerations Proper care of a TV does not require much. Following the recommendations below will assure long life and minimize repairs: Subdued lighting is preferred for best viewing conditions attempt to tell you how to arrange your room! but I will not Locate the TV away from extremes of hot and cold. Avoid damp or dusty locations if possible. (Right you say, keep dreaming!) Allow adequate ventilation - TVs use more power than any of your other A/V components. Heat buildup takes its toll on electronic components. Leave at least 3 inches on top and sides for air circulation if the entertainment center does not have a wide open back panel. Do not pile other components like VCRs on top of the TV if possible (see below). Do not put anything on top of the TV that might block the ventilation grill in the rear or top of the cover. This is the major avenue for the convection needed to cool internal components. If possible, locate the VCR away from the TV. Some VCRs are particularly sensitive to interference from the TV's circuitry and while this won't usually damage anything, it may make for less than optimal performance due to RF interference. The reverse is sometimes true as well. If possible, locate your computer monitor away from the TV. Interaction of the electromagnetic fields of the deflection systems may result in one or both displays jiggling, wiggling, or vibrating. Locate loudspeakers and other sources of magnetic fields at least a couple of feet from the TV. This will minimize the possibility of color purity or geometry problems. Make sure all input-output video and audio connections are tight and secure to minimize intermittent or noisy pictures and sound. Use proper high quality cable only long enough to make connections conveniently. Finally, store video cassettes well away from all electronic equipment including and especially loudspeakers. Heat and magnetic fields will rapidly turn your priceless video collection into so much trash. The operation of the TV depends on magnetic fields for beam deflection. Enough said. 5.2) Preventive maintenance Preventive maintenance for a TV is pretty simple - just keep the case clean and free of obstructions. Clean the screen with a soft cloth just dampened with water and at most, mild detergent. DO NOT use anything so wet that liquid may seep inside of the set around the edge of the picture tube - you could end up with a very expensive repair bill when the liquid shorts out the main circuit board lurking just below. If the set has a protective flat glass faceplate, there is usually an easy way (on newer sets with this type of protection) of removing it to get at the inner face of the CRT. Clean both the CRT and the protective glass with a soft damp cloth and dry thoroughly. If you have not cleaned the screen for quite a while, you will be amazed at the amount of black grime that collects due to the static buildup from the high voltage CRT supply. In really dusty situations, periodically vacuuming inside the case and the use of contact cleaner for the controls might be a good idea but realistically, you will not do this so don't worry about it. Chapter 6) 6.1) TV Troubleshooting Safety TVs and computer or video monitors are among the more dangerous of consumer electronics equipment when it comes to servicing. (Microwave ovens are probably the most hazardous due to high voltage at high power.) There are two areas which have particularly nasty electrical dangers: the non-isolated line power supply and the CRT high voltage. Major parts of nearly all modern TVs and many computer monitors are directly connected to the AC line - there is no power transformer to provide the essential barrier for safety and to minimize the risk of equipment damage. In the majority of designs, the live parts of the TV or monitor are limited to the AC input and line filter, degauss circuit, bridge rectifier and main filter capacitor(s), low voltage (B+) regulator (if any), horizontal output transistor and primary side of the flyback (LOPT) transformer, and parts of the startup circuit and standby power supply. The flyback generates most of the other voltages used in the unit and provides an isolation barrier so that the signal circuits are not line connected and safer. Since a bridge rectifier is generally used in the power supply, both directions of the polarized plug result in dangerous conditions and an isolation transformer really should be used - to protect you, your test equipment, and the TV, from serious damage. Some TVs do not have any isolation barrier whatsoever - the entire chassis is live. These are particularly nasty. The high voltage to the CRT, while 200 times greater than the line input, is not nearly as dangerous for several reasons. First, it is present in a very limited area of the TV or monitor - from the output of the flyback to the CRT anode via the fat red wire and suction cup connector. If you don't need to remove the mainboard or replace the flyback or CRT, then leave it alone and it should not bite. Furthermore, while the shock from the HV can be quite painful due to the capacitance of the CRT envelope, it is not nearly as likely to be lethal since the current available from the line connected power supply is much greater. 6.2) Safety Guidelines These guidelines are to protect you from potentially deadly electrical shock hazards as well as the equipment from accidental damage. Note that the danger to you is not only in your body providing a conducting path, particularly through your heart. Any involuntary muscle contractions caused by a shock, while perhaps harmless in themselves, may cause collateral damage - there are many sharp edges inside this type of equipment as well as other electrically live parts you may contact accidentally. The purpose of this set of guidelines is not to frighten you but rather to make you aware of the appropriate precautions. Repair of TVs, monitors, microwave ovens, and other consumer and industrial equipment can be both rewarding and economical. Just be sure that it is also safe! Don't work alone - in the event of an emergency another person's presence may be essential. Always keep one hand in your pocket when anywhere around a powered line-connected or high voltage system. Wear rubber bottom shoes or sneakers. Don't wear any jewelry or other articles that could accidentally contact circuitry and conduct current, or get caught in moving parts. Set up your work area away from possible grounds that you may accidentally contact. Know your equipment: TVs and monitors may use parts of the metal chassis as ground return yet the chassis may be electrically live with respect to the earth ground of the AC line. Microwave ovens use the chassis as ground return for the high voltage. In addition, do not assume that the chassis is a suitable ground for your test equipment! If circuit boards need to be removed from their mountings, put insulating material between the boards and anything they may short to. Hold them in place with string or electrical tape. Prop them up with insulation sticks plastic or wood. If you need to probe, solder, or otherwise touch circuits with power off, discharge (across) large power supply filter capacitors with a 2 W or greater resistor of 100-500 ohms/V approximate value (e.g., for a 200 V capacitor, use a 20K-100K ohm resistor). Monitor while discharging and/or verify that there is no residual charge with a suitable voltmeter. In a TV or monitor, if you are removing the high voltage connection to the CRT (to replace the flyback transformer for example) first discharge the CRT contact (under the insulating cup at the end of the fat red wire). Use a 1M-10M ohm 1W or greater wattage resistor on the end of an insulating stick or the probe of a high voltage meter. Discharge to the metal frame which is connected to the outside of the CRT. For TVs and monitors in particular, there is the additional danger of CRT implosion - take care not to bang the CRT envelope with your tools. An implosion will scatter shards of glass at high velocity in every direction. There are several tons of force attempting to crush the typical CRT. Always wear eye protection. Connect/disconnect any test leads with the equipment unpowered and unplugged. Use clip leads or solder temporary wires to reach cramped locations or difficult to access locations. If you must probe live, put electrical tape over all but the last 1/16 of the test probes to avoid the possibility of an accidental short which could cause damage to various components. Clip the reference end of the meter or scope to the appropriate ground return so that you need to only probe with one hand. Perform as many tests as possible with power off and the equipment unplugged. For example, the semiconductors in the power supply section of a TV or monitor can be tested for short circuits with an ohmmeter. Use an isolation transformer if there is any chance of contacting line connected circuits. A Variac(tm) is not an isolation transformer! The use of a GFCI (Ground Fault Circuit Interrupter) protected outlet is a good idea but will not protect you from shock from many points in a line connected TV or monitor, or the high voltage side of a microwave oven, for example. (Note however, that, a GFCI may nuisanse trip at power-on or at other random times due to leakage paths (like your scope probe ground) or the highly capacitive or inductive input characteristics of line powered equipment.) A fuse or circuit breaker is too slow and insensitive to provide any protection for you or in many cases, your equipment. However, these devices may save your scope probe ground wire should you accidentally connect it to a live chassis. Don't attempt repair work when you are tired. Not only will you be more careless, but your primary diagnostic tool - deductive reasoning - will not be operating at full capacity. Finally, never assume anything without checking it out for yourself! Don't take shortcuts! 6.3) Troubleshooting tips Many problems have simple solutions. Don't immediately assume that your problem is some combination of esoteric complex convoluted failures. For a TV, it may just be a bad connection or blown fuse. Remember that the problems with the most catastrophic impact on operation like a dead TV usually have the simplest solutions. The kind of problems we would like to avoid at all costs are the ones that are intermittent or difficult to reproduce: the occasional interference or a TV that refuses to play 'StarTrek Voyager'. If you get stuck, sleep on it. Sometimes, just letting the problem bounce around in your head will lead to a different more successful approach or solution. Don't work when you are really tired - it is both dangerous (especially with respect to TVs) and mostly non-productive (or possibly destructive). Whenever working on precision equipment, make copious notes and diagrams. You will be eternally grateful when the time comes to reassemble the unit. Most connectors are keyed against incorrect insertion or interchange of cables, but not always. Apparently identical screws may be of differing lengths or have slightly different thread types. Little parts may fit in more than one place or orientation. Etc. Etc. Pill bottles, film canisters, and plastic ice cube trays come in handy for sorting and storing screws and other small parts after disassembly. This is particularly true if you have repairs on multiple pieces of equipment under way simultaneously. Select a work area which is wide open, well lighted, and where dropped parts can be located - not on a deep pile shag rug. The best location will also be relatively dust free and allow you to suspend your troubleshooting to eat or sleep or think without having to pile everything into a cardboard box for storage. Another consideration is ESD - Electro-Static Discharge. Some components (like ICs) in a TV are vulnerable to ESD. There is no need to go overboard but taking reasonable precautions such as getting into the habit of touching the chassis first before any of the electronic components is a good practice. A basic set of precision hand tools will be all you need to disassemble a TV and perform most adjustments. These do not need to be really expensive but poor quality tools are worse than useless and can cause damage. Needed tools include a selection of Philips and straight blade screwdrivers, socket drivers, needlenose pliers, wire cutters, tweezers, and dental picks. For adjustments, a miniature (1/16 blade) screwdriver with a non-metallic tip is desirable both to prevent the presence of metal from altering the electrical properties of the circuit and to minimize the possibility of shorting something from accidental contact with the circuitry. A set of plastic alignment tools will be useful for making adjustments to coils and RF transformers. A low power (e.g., 25 W) fine tip soldering iron and fine rosin core solder will be needed if you should need to disconnect any soldered wires (on purpose or by accident) or replace soldered components. A higher power iron or small soldering gun will be needed for dealing with larger components. For thermal or warmup problems, a can of 'cold spray' or 'circuit chiller' (they are the same) and a heat gun or blow dryer come in handy to identify components whose characteristics may be drifting with temperature. Using the extension tube of the spray can or making a cardboard nozzle for the heat gun can provide very precise control of which components you are affecting. For info on useful chemicals, adhesives, and lubricants, see Repair Briefs, an Introduction as well as other documents available at this site. 6.4) Test equipment Don't start with the electronic test equipment, start with some analytical thinking. Your powers of observation (and a little experience) will make a good start. Your built in senses and that stuff between your ears represents the most important test equipment you have. However, some test equipment will be needed: Multitester (DMM or VOM) - This is essential for checking of power

effects (fast play) modes. Many sets no longer have any horizontal size adjustments and depend on accurate regulation of the voltage to the horizontal output stage to control horizontal size. There may be a B+ adjustment to perform first. On those that do, the adjustment may either be done by setting the B+ voltage, by a pot, or a width coil in series with the horizontal deflection coils. Modern sets do not generally have any linearity control but you may find this on older models. You will need to go back and forth between size and linearity as these adjustments are usually not independent. Some of the newest sets control all these parameters via settings in non-volatile memory and use service menus accessed via the remote control for nearly all setup adjustments. 7.6) Vertical position, size, and linearity adjustment Vertical position may be set via a switch or jumper, a pot, or (mostly in B/W TVs) a set of rings on the CRT neck. Vertical size should be set so that there is about 10-15 percent overscan top and bottom. This will allow ample margin for power line voltage fluctuations, component aging, and the reduction in raster size that may occur with some VCR special effects (fast play) modes. Some sets no longer have any vertical size adjustments and depend on the accurate regulation of the voltage to the vertical output stage to control vertical size. On those that do, the adjustment is usually a pot in the vertical output circuitry. If your set has a linearity control, you will need to adjust this in conjunction with the size control as these are usually not independent. Some of the newest sets control all these parameters via settings in non-volatile memory and use service menus accessed via the remote control for nearly all setup. 7.7) Pincushion adjustments There may be two controls - amplitude and phase. Pincushion amplitude as its name implies, controls the size of the correction. Pincushion phase affects where on the sides it is applied. Don't expect perfection. If the controls have no effect, there is probably a fault in the pincushion correction circuitry. It is best to make these adjustments with a crosshatch or dot test pattern 7.8) Geometry adjustment This refers to imperfections in the shape of the picture not handled by the pincushion and size adjustments. These types of defects include trapezoidal or keystone shaped raster and jogs or wiggles around the periphery of the raster. Unfortunately, one way these are handled at the factory is to glue little magnets to strategic locations on the CRT and/or rotate little magnets mounted on the yoke frame. Unless you really cannot live with the way it is (assuming there isn't something actually broken), leave these alone! You can end up with worse problems. In any case, carefully mark the position AND orientation of every magnet so that if this happens, you can get back to where you started. If the magnets are on little swivels, some experimenting with them one at a time may result in some improvement. Of course, it is best to obtain a service manual and follow its instructions. 7.9) Why is the convergence on my set bad near the edges Very simple - nothing is quite perfect. Perfect convergence is not even necessarily possible in theory with the set of adjustments available on a typical TV. It is all a matter of compromises. Consider what you are trying to do: get three electron beams which originate from different electron guns to meet at a single point within a fraction of a mm everywhere on the screen. This while the beams are scanning at an effective writing rate of 20,000 mph across the face of a 27 CRT in a variable magnetic environment manufactured at a price you can afford without a second mortgage! 7.10) CRT purity and convergence problem Purity assures that each of the beams for the 3 primary colors red, green, and blue - strikes only the proper phosphor dots for that color. A totally red scene will appear pure red and so forth. Symptoms of poor purity are blotches of discoloration on the screen. Objects will change shades of color when the move from one part of the screen to another. Convergence refers to the control of the instantaneous positions of the red, green, and blue spots as they scan across the face of the CRT so that they are as nearly coincident as possible. Symptoms of poor convergence are colored borders on solid objects or visible separate R, G, and B images of fine lines or images, NOTE: It is best to face the set North-South (front-to-back) when doing any purity and convergence adjustments. Since you have no way of knowing what orientation will eventually be used, this is the best compromise as the earth's magnetic field will be aligned front-back. Of course, if you know the final orientation of the TV in your entertainment center - and you don't expect to be redecorating, use that instead. First, make sure no sources of strong magnetic fields are in the vicinity of the TV - loudspeakers, refrigerator magnets, MRI scanners, etc. A nearby lightening strike or EMP from a nuclear explosion can also affect purity. Cycle power a couple of times to degauss the CRT (1 minute on, 20 minutes off) - see the section: Degaussing (demagnetizing) the CRT. If the built in degaussing circuits have no effect, use an external manual degaussing coil. Assuming this doesn't help, you will need to set the internal purity and/or convergence adjustments on the CRT. First, mark the positions of all adjustments - use white paint, 'White out', or a Magic Marker on the ring magnets on the neck of the CRT, the position and tilt of the deflection yoke, and any other controls that you may touch deliberately or by accident. NOTE: if your set is still of the for these adjustments, don't even a service manual and follow it to the knobs is clearly marked (some job of this). 7.11) type with a drawer or panel of knobs think about doing anything without the letter unless the functions of all manufacturers actually do a pretty good CRT purity adjustment Purity on modern CRTs is usually set by a combination of a set of ring magnets just behind the deflection yoke on the neck of the CRT and the position of the yoke fore-aft. As always, mark the starting position of all the rings and make sure you are adjusting the correct set if rings! Use the following purity adjustment procedure as a general guide only. Depending on the particular model TV, the following purity adjustment procedure may substitute green for red. This depends on the gun placement in the CRT. This description is based on the SAMs Photofact for the RCA CTC111C chassis which uses a slot-mask CRT. The procedures for dot-mask and Trinitron (aperture grille) CRTs will vary slightly. See you service manual! Obtain a white raster (sometimes there is a test point that can be grounded to force this). Then, turn down the bias controls for blue and green so that you have a pure red raster. Let the set warm up for a minimum of 15 minutes. Loosen the deflection yoke clamp and move the yoke as far back as it will go, Adjust the purity magnets to center the red vertical raster on the screen. Move the yoke forward until you have the best overall red purity. Now, move the yoke forward until you have the best overall red purity. Tighten the clamp securely and reinstall the rubber wedges (if you set has these) to stabilize the yoke position. Reset the video adjustments you touched to get a red raster. 7.12) CRT convergence adjustment In the good old days when TVs were TVs (and not just a picture tube with a little circuit board attached) there were literally drawers full of knobs for setting convergence. One could spend hours and still end up with a less than satisfactory picture. As the technology progressed, the number of electronic adjustments went down drastically so that today there are very few if any. Unless you want a lot of frustration, I would recommend not messing with convergence. You could end up a lot worse. I have no idea what is used for convergence on your set but convergence adjustments are never quite independent of one another. You could find an adjustment that fixes the problem you think you have only to discover some other area of the screen is totally screwed. In addition, there are adjustments for geometry and purity and maybe others that you may accidentally move without even knowing it until you have buttoned up the set. WARNING: Accurately mark the original positions - sometimes you will change something that will not have an obvious effect but will be noticeable later on. So it is extremely important to be able to get back to where you started. If only red/green vertical lines are offset, then it is likely that only a single ring needs to be moved - and by just a hair. But, you may accidentally move something else! If you really cannot live with it, make sure you mark everything very carefully so you can get back to your current state. A service manual is essential! Convergence is set using a white crosshatch or dot test pattern. If you do not have a test pattern generator, any static scene (from a camcorder or previously recorded tape, for example) with a lot of fine detail will suffice. Turn the color control all the way down so you have a B/W picture. Static convergence sets the beams to be coincident in the exact center of the screen. This is done using a set of ring magnets behind the purity magnets on the CRT neck. From the SAMs for the RCA CTC111C: adjust the center set of magnets to converge blue to green at the center of the screen. Adjust the rear set of magnets to converge red to green at the center of the screen. Your set may have a slightly different procedure. Dynamic convergence adjusts for coincidence at the edges and corners. On old tube, hybrid, and early solid state TVs, dynamic convergence was accomplished with electronic adjustments of which there may have been a dozen or more that were not independent. With modern sets, all convergence is done with magnet rings on the neck of the CRT, magnets glued to the CRT, and by tilting the deflection yoke. The clamp in conjunction with rubber wedges or set screws assures that the yoke remains in position. From the SAMs for the RCA CTC111C: Loosen the screws at the 6 o'clock and 10 o'clock positions to permit the yoke to be tilted vertically. Rock yoke up and down to converge the right and left sides of the screen. Tighten screw at 6 o'clock and loosen screw at 3 o'clock to permit the yoke to be tilted horizontally. Rock yoke from side to side to converge the top and bottom of the screen. Tighten screws at 3 o'clock and 10 o'clock. Many sets simply use the main clamp which locks the yoke to the neck of the CRT in conjunction with rubber wedges between the yoke and the funnel of the CRT to stabilize the yoke position position. Refer to your service manual. (Is this beginning to sound repetitious? For additional comments on convergence adjustments, see the sections: Tony's notes on setting convergence on delta gun CRTs and Saga and General setup for large CRT TVs. 7.13) Tilted picture You have just noticed that the picture on your fancy (or cheap) TV is not quite horizontal - not aligned with the front bezel. Note that often there is some keystoning as well where the top and bottom or left and right edges of the picture are not quite parallel - which you may never have noticed until now. Since this may not be correctable, adjusting tilt may represent a compromise at best between top/bottom or left/right alignment of the picture edges. You may never sleep again knowing that your TV picture is not perfect! BTW, I can sympathize with your unhappiness. Nothing is more annoying than a just noticeable imperfection such as this. There are several possible causes for a tilted picture: You just became aware of it but nothing has changed. Don't dismiss this offhand. It is amazing how much we ignore unless it is brought to our attention. Are you a perfectionist? There is an external tilt control which may be misadjusted. Newer Sony monitors have this (don't know about TVs) - a most wonderful addition. Too bad about the stabilizing wires on Trinitron CRTs. A digital control may have lost its memory accidentally. The circuitry could have a problem. There is an internal tilt control that is misadjusted. Not common. The deflection yoke on the CRT has gotten rotated or was not oriented correctly at the time of the set's manufacture. Sometimes, the entire yoke is glued in place in addition to being clamped adding another complication. On some monitors, you can rotate the CRT slightly instead but probably not on your TV. If the TV was recently bumped or handled roughly, the yoke may have been knocked out of position. But in most cases, the amount of abuse required to do this with the yoke firmly clamped and/or glued would have totally destroyed the set in the process. There is a risk (in addition to the risk of frying yourself on the various voltages present inside as operating TV) of messing up the convergence or purity when fiddling with the yoke or anything around it since the yoke position on the neck of the tube and its tilt may affect purity and convergence. Tape any rubber wedges under the yoke securely in place as these will maintain the proper position and tilt of the yoke while you are messing with it. (Don't assume the existing tape will hold - the adhesive is probably dry and brittle). External magnetic fields can sometimes cause a rotation without any other obvious effects - have you changed the TV's location? Chapter 8) 8.1) Low Voltage Power Supply Problems Low voltage power supply fundamentals TVs require a variety of voltages (at various power levels) to function. The function of the low voltage power supply is to take the AC line input of either 115 VAC 60 Hz (220 VAC 50 Hz or other AC power in Europe and elsewhere) and produce some of these DC voltages. In all cases, the power to the horizontal output transistor of the horizontal deflection system is obtained directly from the low voltage power supply. In some cases, a variety of other DC voltages are derived directly from the AC line by rectification, filtering, and regulation. In other designs, however, most of the low voltages are derived from secondary windings on the flyback (LOPT) transformer of the horizontal deflection system. In still other designs, there is a separate switchmode power supply that provides some or all of these voltages. There are also various (and sometimes convoluted) combinations of any or all of the above. There will always be: A power switch, relay, or triac to enable main power. A set of rectifiers - usually in a bridge configuration - to turn the AC into DC. Small ceramic capacitors are normally placed across the diodes to reduce RF interference. One or more large filter capacitors to smooth the unregulated DC. In the U.S., this is most often a voltage around 150-160 V DC. In countries with 220 VAC power, it will typically be around 300-320 V DC. A discrete, hybrid, or IC regulator to provide stable DC to the horizontal deflection system. Sometimes feedback from a secondary output of the flyback or even the high voltage is used. This regulator may be either a linear or switching type. In some cases, there is no regulator. Zero or more voltage dividers and/or regulators to produce additional voltages directly from the line power. This relatively rare except for startup circuits. These voltages will not be isolated from the line. A degauss control circuit usually including a thermistor or Posistor (a combination of a heater disk and Positive Temperature Coefficient (PTC) thermistor in a single package). When power is turned on, a relatively high AC current is applied to the degauss coil wrapped around the periphery of the CRT. The PTC thermister heats up, increases in resistance, and smoothly decreases the current to nearly zero over a couple of seconds. A startup circuit for booting the horizontal deflection if various voltages to run the TV are derived from the flyback. This may be an IC or discrete multivibrator or something else running off a non-isolated voltage or the standby power supply. A standby power supply for the microcontroller and remote sensor. Usually, this is a separate low voltage power supply using a small power transformer for line isolation. Always use an isolation transformer when working on a TV but this is especially important - for your safety - when dealing with the non-isolated line operated power supply section. Read and follow the safety guidelines. 8.2) Power button on set is flakey If the on/off (or other button) on the set itself behaves erratically but the remote control works fine, then it could be a dirty button or cable or other connections to the switch PCB, particularly if the buttons on the set itself are rarely used. There could possibly be a bad pullup resistor or something of that sort - but is it worth the effort to locate? Why not just continue to use the remote? There is no reason to suspect that it will develop similar symptoms. However, there is some risk that if the button is dirty, you may find the TV coming on at random times in the middle of the night (of course!). I think I have an older Sylvania that does that sort of thing - don't really know as I never use the power button on the set! If power is controlled by a hard switch - a pull or click knob, or mechanical push-push switch and this has become erratic due to worn contacts, replacements are available but often only directly from the original manufacturer to physically fit and (where applicable) have the volume or other controls built in. As an alternative, consider mounting a small toggle switch on the side of the cabinet to substitute for the broken switch. This will almost certainly be easier and cheaper - and quite possibly, more reliable. 8.3) TV blows fuse If the fuse really blows absolutely instantly with no indication that the circuits are functioning (no high pitched horizontal deflection whine (if your dog hides under the couch whenever the TV is turned on, deflection is probably working)), then this points to a short somewhere quite near the AC power input. The most common places would be: Degauss Posistor - very likely. Horizontal output transistor. Power supply regulator if there is one. Power supply chopper (switchmode) transistor if there is one. Diode(s) in main bridge Main filter capacitor(s). You should be able to eliminate these one by one. Unplug the degauss coil as this will show up as a low resistance. First, measure across the input to the main power rectifiers - it should not be that low. A reading of only a few ohms may mean a shorted rectifier or two or a shorted Posistor. Test the rectifiers individually or remove and retest the resistance. Some sets use a Posistor for degauss control. This is a little cubical (about 1/2 x 3/4 x 1) component with 3 legs. It includes a line operated heater disk (which often shorts out) and a PTC thermister to control current to the degauss coil. Remove the posistor and try power. If the monitor now works, obtain a replacement but in the meantime you just won't have the automatic degauss. If these test good, use an ohmmeter with the set unplugged to measure the horizontal output transistor. Even better to remove it and measure it. C-E should be high in at least one direction. B-E may be high or around 50 ohms but should not be near 0. If any readings are under 5 ohms, the transistor is bad. The parts sources listed at the end of this document will have suitable replacements. If the HOT tests bad, try powering the set first with your light bulb and if it just flashes once when the capacitor is charging, then put a fuse in and try it. The fuse should not blow with the transistor removed. Of course, not much else will work either. If it tests good, power the set without the transistor and see what happens. If the fuse does not blow, then with the good transistor (assuming it is not failing under load), it would mean that there is some problem with the driving circuits possibly or with the feedback from the voltages derived from the horizontal not regulating properly. Look inside the TV and see if you can locate any other large power transistors in metal (TO3) cans or plastic (TOP3) cases. There may be a separate transistor that does the low voltage regulation or a separate regulator IC. Some TVs have a switchmode power supply that runs off a different transistor than the HOT. There is a chance that one of these may be bad. If it is a simple transistor, the same ohmmeter check should be performed. If none of this proves fruitful, it may be time to try to locate a schematic. A blown fuse is a very common type of fault due to poor design very often triggered by power surges due to outages or lightening storms. However, the most likely parts to short are easily tested, usually in-circuit, with an ohmmeter and then easily removed to confirm. If you find the problem and repair it yourself, the cost is likely to be under $25. 8.4) Internal fuse blew during lightening storm (or elephant hit power pole) Power surges or nearby lightening strikes can destroy electronic equipment. However, most of the time, damage is minimal or at least easily repaired. With a direct hit, you may not recognize what is left of it! Ideally, electronic equipment should be unplugged (both AC line and phone line!) during electrical storms if possible. Modern TVs, VCRs, microwave ovens, and even stereo equipment is particularly susceptible to lightening and surge damage because some parts of the circuitry are always alive and therefore have a connection to the AC line. Telephones, modems, and faxes are directly connected to the phone lines. Better designs include filtering and surge suppression components built in. With a near-miss, the only thing that may happen is for the internal fuse to blow or for the microcontroller to go bonkers and just require power cycling. There is no possible protection against a direct strike. However, devices with power switches that totally break the line connection are more robust since it takes much more voltage to jump the gap in the switch than to fry electronic parts. Monitors and TVs may also have their CRTs magnetized due to the electromagnetic fields associated with a lightening strike - similar but on a smaller scale to the EMP of a nuclear detonation. Was the TV operating or on standby at the time? If it was switched off using an actual power switch (not a logic pushbutton or the remote control), then either a component in front of the switch has blown, the surge was enough to jump the gap between the switch contacts, or it was just a coincidence (yeh, right). If the TV was operating or on standby or has no actual power switch, then a number of parts could be fried. TVs usually have their own internal surge protection devices like MOVs (Metal Oxide Varistors) after the fuse. So it is possible that all that is wrong is that the line fuse has blown. Remove the cover (unplug it first!) and start at the line cord. If you find a blown fuse, remove it and measure across the in-board side of fuse holder and the other (should be the neutral) side of the line. The ohmmeter reading should be fairly high - well certainly not less than 100 ohms - in at least one direction. You may need to unplug the degaussing coil to get a reasonable reading as its resistance may be 25 or 30 ohms. If the reading is really low, there are other problems. If the resistance checks out, replace the fuse and try powering the TV. There will be 3 possibilities: It will work fine, problem solved. It will immediately blow the fuse. This means there is at least one component shorted - possibilities include an MOV, line rectifiers, main filter cap, regulator transistor, horizontal output transistor, etc. You will need to check with your ohmmeter for shorted semiconductors. Remove any that are suspect and see of the fuse now survives (use the series light bulb to cut your losses - see the section: The series light bulb trick. It will not work properly or appear dead. This could mean there are open fusable resistors other defective parts in the power supply or elsewhere. In this case further testing will be required and at some point you may need the schematic. If the reading is very low or the fuse blows again, see the section: TV blows fuse. 8.5) Fuse replaced but TV clicks with power-on but no other action The click probably means that the power relay is working, though there could be bad contacts. Since the fuse doesn't blow now (you did replace it with one of the same ratings, right?), you need to check for: Other blown fuses - occasionally there are more than one in a TV. Replace with one of exactly the same ratings. Open fusable resistors. These sometimes blow at the same time or in place of the fuses. They are usually low values like 2 ohms and are in big rectangular ceramic power resistor cases or smaller blue or gray colored cylindrical power resistors. They are supposed to protect expensive parts like the HOT but often blow at the same time. If any of these are bad, they will need to be replaced with flameproof resistors of the same ratings (though you can substitute an ordinary resistor for testing purposes). Before applying power, check (for shorts): Rectifier diodes Horizontal Output Transistor (HOT) Regulator pass or chopper transistor (if present) Main filter capacitor An initial test with an ohmmeter can be done while in-circuit. The resistance across each diode and the collector to emitter of the transistors should be relatively high - a few hundred ohms at lest in at least one direction (in-circuit). If there is a question, unsolder one side of each diode and check - should be in the Megohms or higher in one direction. Removed from the circuit, the collector-emitter resistance should be very high in one direction at least. Depending on the type, the base-emitter resistance may be high in one direction or around 50 ohms. If any reading on a semiconductor device is under 10 ohms - then the device most likely bad. Assuming that you do not have a schematic, you should be able to locate the rectifiers near where the line cord is connected and trace the circuit. The transistors will be either in a TO3 large metal can or a TOP3 plastic package - on heat sinks. The filter capacitor should eventually measure high in one direction (it will take a while to charge from your ohmmeter). It could still be failing at full voltage, however. If you find one bad part, still check everything else as more than one part may fail and just replacing one may cause it to fail again. Assuming everything here checks out, clip a voltmeter set on its 500 V scale or higher across the horizontal output transistor and turn the power on. Warning - never measure this point if the horizontal deflection is operating. it is ok now since the set is dead. If the voltage here is 100-150, then there is a problem in the drive to the horizontal output circuit. If it is low or 0, then there are still problems in the power supply or with the winding on the flyback transformer. Other possible problems: Bad hybrid voltage regulator bad startup circuit Bad relay contacts as mentioned above. 8.6) Power-on tick-tick-tick or click-click-click but no other action A variety of power supply or startup problems can result in this or similar behavior. Possibilities include: Lack of startup horizontal drive - see the section: Startup problems. The main regulator is cycling on overvoltage due to lack of load. Excessive load or faulty power supply cycling on its overcurrent protection circuit. HV shutdown, or some other system detecting an out of regulation condition. However, in this case, there should be some indication that the deflection and HV is attempting to come up - momentary whine, static on the screen, etc. A dried up main filter capacitor or other filter capacitor in the low voltage power supply that is producing an out-of-regulation condition until it warms up. A bad filter capacitor on the output of a series regulator may result in excessive voltage and subsequent shutdown. A problem with the microcontroller, relay or its driver, or standby power supply. One possible test would be to vary the line voltage and observe the set's behavior. It may work fine at one extreme (usually low) or the other. This might give clues as to what is wrong. Also see the section: Dead TV with periodic tweet-tweet-tweet or flub-flub-flub. 8.7) No picture or raster and no sound The screen is blank with no raster at all. There are indications that the channel numbers are changing in the display. This indicates that some of the low voltages are present but these may be derived from the standby supply. Assuming there is no deflection and no HV, you either have a low voltage power supply problem, bad startup circuit, or bad horizontal output transistor (HOT)/bad parts in the horizontal deflection. Check for bad fuses. (If you have HV as indicated by static electricity on the front of the screen and you hear the high pitched whine of the horizontal deflection when it is turned on, then the following does not apply). Use an ohmmeter to test the HOT for shorts. If it is bad, look for open fusable resistors or other fuses you did not catch. Assuming it is good, measure the voltage on the collector-emitter of the HOT (this is safe if there is no deflection). You should see the B+ - probably between 100 and 150 V. If there is no voltage, you have a low voltage power supply problem and/or you have not found all the bad/open parts. If there is voltage and no deflection (no high pitched whine and no HV), you probably have a startup problem - all TVs need some kind of circuit to kick start the horizontal deflection until the auxiliary power outputs of the flyback are available. Some Zeniths use a simple multivibrator for this - a couple of transistors. Others power the horizontal osc. IC from a special line-derived voltage. The multivibrator type are sometimes designed to fail if someone keeps turning the set on and off (like kids playing) since the power rating is inadequate. Test the transistors if it is that type with an ohmmeter. If one is shorted, you have a problem. The usual way a TV service person would test for startup problems is to inject a signal to the base of the HOT of about 15.75 KHz. If the TV then starts and runs once this signal is removed, the diagnosis is confirmed. This is risky - you can blow things up if not careful (including yourself). If you hear the high pitched whine of the deflection and/or feel some static on the scree, confirm that the horizontal deflection and high voltage are working by adjusting the SCREEN control (probably on the flyback). If you can get a raster then your problem is probably in the video or chroma circuits, not the deflection or high voltage. 8.8) Reduced width picture and/or hum bars in picture and/or hum in sound The most likely cause is a dried up main filter capacitor. Once the effective capacitance drops low enough, 120 Hz (or 100 Hz in countries with 50 Hz power) ripple will make its way into the regulated DC supply (assuming full wave rectification). Another likely cause of similar symptoms is a defective low voltage regulator allowing excessive ripple. The regulator IC could be bad or filter capacitor following the IC could be dried up. Either of these faults may cause: A pair of wiggles and/or hum bars in the picture which will float up the screen. For NTSC where the power line is 60 Hz but the frame rate is 59.94 Hz, it will take about 8 seconds for each bar to pass a given point on the screen. (On some sets, a half wave recitifier is used resulting in a single wiggle or hum bar). Hum in the sound. turned down. This may or may not be noticeable with the volume Possible regulation problems resulting in HV or total shutdown or power cycling on and off. The best approach to testing the capacitors is to clip a good capacitor of approximately the same uF rating and at least the same voltage rating across the suspect capacitor (with the power off). A capacitor meter can also be used but the capacitor may need to be removed from the circuit. Once the capacitors have been confirmed to be good, voltage measurements on the regulator should be able to narrow down the problem to a bad IC or other component. 8.9) TV power cycling on and off The power light may be flashing or if you are runing with a series light bulb it may be cycling on and off continuously. There may be a chirping or clicking sound from inside the set. (NOTE: using too small a light bulb for the size of the TV may also result in this condition.) If there is a low voltage regulator or separate switching supply, it could be cycling on and off if the horizontal output, flyback, or one of its secondary loads were defective. Does this TV have a separate low voltage regulator and/or switching power supply or is it all part of the flyback circuit? For the following, I assume it is all in one (most common). Some simple things to try first: Verify that the main filter capacitor is doing its job. Excessive ripple on the rectified line voltage bus can cause various forms of shutdown behavior. An easy test is to jumper across the capacitor with one of at least equal voltage rating and similar capacitance (make connections with power off!). Use a Variac, the TV works an indication usually latch 8.10) if possible, to bring up the input voltage slowly and see if at any point without shutting down. If it does, this could be of X-ray protection circuit kicking in, though this will and keep the set shut off if excessive HV were detected. Dead TV with periodic tweet-tweet-tweet or flub-flub-flub A TV which appears to be dead except for a once a second or so tweet or flub usually indicates an overload fault in the power supply has a short in one of its load circuits, very often a shorted rectifier. It could also be the flyback, but check the the loads first. Wait a few minutes for the filter caps to discharge (but stay away from the CRT HV connector as it may retain a dangerous and painful charge for a long time), use an ohmmeter across the various diodes in the power supply. Using an ohmmeter on the rectifier diodes, the resistance in at least one direction should be greater than 100 ohms. If it is much less (like 0 or 5 ohms), then the diode is probably bad. Unsolder and check again - it should test infinite (greater than 1M ohms) in one direction. Other possible causes: Bad solder connections. Other shorted components like capacitors. Other problems in the power supply. Bad flyback. Short or excessive load on secondary supplies fed from flyback. Problem with startup drive (cycling on overvoltage). 8.11) Shorted Components A failure of the horizontal output transistor or power supply switchmode transistor will blow a fuse or fusable resistor. Look for blown fuses and test for open fusable resistors in the power circuits. If you find one, then test the HOT and/or switchmode transistor for shorts. Other possibilities: rectifier diodes or main filter capacitor. While you are at it, check for bad connections - prod the circuit board with an insulated stick when the problem reoccurs - as these can cause parts to fail. 8.12) Startup problems - nothing happens, click, or tick-tick-tick sound TVs and monitors usually incorporate some kind of startup circuit to provide drive to the horizontal output transistor (HOT) until the flyback power supply is running. Yes, TVs and monitors boot just like computers. There are two typical kinds of symptoms: power on click but nothing else happens or a tick-tick-tick sound indicating cycling of the low voltage (line regulator) but lack of startup horizontal drive. Check the voltage on the horizontal output transistor (HOT). If no voltage is present, there may be a blown fuse or open fusable resistor - and probably a shorted HOT. However, if the voltage is normal (or high) - usually 100-150 V, then there is likely a problem with the startup circuit not providing initial base drive to the HOT. The startup circuits may take several forms: Discrete multivibrator or other simple transistor circuit to provide base drive to the HOT. IC which is part of deflection chain powered off of a voltage divider or transformer. Other type of circuit which operates off of the line which provides some kind of drive to the HOT. The startup circuit may operate off of the standby power supply or voltage derived from non-isolated input. Be careful - of course, use an isolation transformer whenever working on TVs and especially for power supply problems. Note that one common way of verifying that this is a startup problem is to inject a 15 KHz signal directly into the HOT base or driver circuit (just for a second or two). If the TV then starts up and continues to run, you know that it is a startup problem. CAUTION: Be careful if you do this. The HOT circuit may be line-connected and it is possible to destroy the HOT and related components if this is not done properly. I once managed to kill not only the HOT but the chopper transistor as well while working in this area. An expensive lesson. I have also seen startup circuits that were designed to fail. Turning the TV on and off multiple times would exceed the power ratings of the components in the startup circuit. Some Zenith models have this 'feature'. When this situation exists, it could be that the circuit is not providing the proper drive or that due to some other circuit condition, the drive is not always sufficient to get the secondary supplies going to the point that the normal circuits take over. I would still check for bad connections - prod the circuit board with an insulated stick when the problem reoccurs 8.13) TV turns off after warming up If you can turn it back on with the s momentary key or power button: When it shuts off, do you need to push the power button once or twice to get it back on? Also, does anything else about the picture or sound change as it warms up? If once, then the controller is shutting the TV down either as a result of a (thermally induced) fault in the controller or it sensing some other problem. Monitoring the voltage on the relay coil (assuming these is one) could help determine what is happening. The controller thinks it is in charge. If twice, then the power supply is shutting down as the controller still thinks it is on and you are resetting it. A couple of possibilities here would be low voltage or high voltage regulation error (excessive high voltage is sensed and causes shutdown to prevent dangerous X-ray emission). A partially dried up main filter capacitor could also cause a shutdown but there might be other symptoms like hum bars in the picture just before this happened. Clipping a good capacitor across the suspect (with power off!) would confirm or eliminate this possibility. If it uses a pull-knob (or other hard on/off switch), then this may be like pulling the plug and would reset any abnormal condition. 8.14) TV doesn't power up immediately The TV may do nothing, cycle on and off for a while, power up and then shutdown in an endless cycle - or at least for a while. Then it comes on and operates normally until it is turned off. A couple of possibilities: The main filter capacitor or other filter capacitors in the low voltage power supply is dried up and this can cause all kinds of regulation problems. The power supply regulator is defective (or marginal) allowing excessive voltage on its output and then the X-ray protection circuitry shuts you down. If you can get access to a Variac, it would be worth bringing up the input voltage slowly and seeing if there is some point at which it would stay on. If there is, then if the picture has serious hum bars in it the main filter cap could be bad. If more or less a decent picture with minor hum bars then it could be the regulator. 8.15) Old TV requires warmup period So, what else is new? In the old days, a TV was expected to take a few minutes (at least) to warm up. We are all spoiled today. Of course, you usually maintained a full time technician or engineer to fiddle with the convergence adjustments! A TV (from around 1983) needs at least 5 min. to warm up (lighting up the screen and making sound if I give it a cold start. Once warmed up, you can it off and on again from the front panel and it will work immediately. Another thing this TV has a sub-power switch in the rear. 1983 sounds a bit late, but sets in the late '70 during the transition from tubes to all solid state chassis often had the 'sub-power' switch providing some power to the filaments of the CRT and other tubes - usually in the deflection and high voltage circuits since these would take a while to heat up and stabilize. The idea was to leave this switch on all the time (except when going on vacation - it was sometimes labeled 'vacation') so that you would have nearly instant warm up. Supposedly, this led to an increased risk of fire as well (see the section: About instant on TVs). If it is a totally solid state chassis, then there is some component - probably a capacitor in the power supply since it affects both picture and sound - that is drifting with temperature and needs to be located with cold spray or a heat gun. 8.16) Relays in the Power Circuitry of TVs What exactly is the purpose of such a relay ... i.e., why doesn't the power switch on the TV just apply power directly instead of through a relay? The usual reason for a relay instead of a knob switch is to permit a remote control to turn power on and off. If your TV does not have a remote, then it is simply the same chassis minus 24 cents worth of circuitry to do the remote function. Isn't marketing wonderful? The only unknown is the coil voltage. It is probably somewhere in the 6-12 volt range. You should be able to measure this on the coil terminals in operation. It will be a DC coil. However, the relay controls the 125 VAC (or 220) which you should treat with respect - it is a lot more dangerous than the 25KV+ on the CRT! Almost certainly, the relay will have 4 connections - 2 for power and 2 for the coil. If it is not marked then, it should be pretty easy to locate the power connection. One end will go to stuff near the AC line and the other end will go to the rectifier or maybe a fusable resistor or something like that. These will likely be beefier than the coil connections which will go between a transistor and GND or some low voltage, or maybe directly into a big microcontroller chip. Of course, the best thing would be to get the schematic. Some big public libraries carry the SAMs photofact series for TVs and VCRs. If not, take 10 minutes and trace it. You should be able to get far enough to determine the relay connections. Once you are sure of the AC connections - measure across them while it is off and also while it is on. While off, you should get 110-125 VAC. While on and working - 0. While on and not working either 110-125 VAC if the relay is not pulling in or 0 if it is and the problem is elsewhere. We can deal with the latter case if needed later on. Note the even if the relay contacts are not working, the problem could still be in the control circuitry not providing the correct coil voltage/current, though not likely. It may be expensive and/or difficult to obtain an exact replacement, but these are pretty vanilla flavored as relays go. Any good electronics distributor should be able to supply a suitable electrical replacement though you may need to be creative in mounting it. 8.17) Flameproof Resistors Flameproof Resistor or Fusable Resistor are often designated by the symbol 'FR'. They are the same. You may see these in the switchmode power supplies used in TVs and monitors. They will look like power resistors but will be colored blue or gray, or may be rectangular ceramic blocks. They should only be replaced with flameproof resistors with identical ratings. They serve a very important safety function. These usually serve as fuses in addition to any other fuses that may be present (and in addition to their function as a resistor, though this isn't always needed). Since your FR has blown, you probably have shorted semiconductors that will need to be replaced as well. I would check all the transistors and diodes in the power supply with an ohmmeter. You may find that the main switch mode transistor has decided to turn into a blob of solder - dead short. Check everything out even if you find one bad part - many components can fail or cause other components to fail if you don't locate them all. Check resistors as well, even if they look ok. Then, with a load on the output of the power supply use a Variac to bring up the voltage slowly and observe what happens. At 50 VAC or less, the switcher should kick in and produce some output though correct regulation may not occur until 80 VAC or more. The outputs voltages may even be greater than spec'd with a small load before regulation is correct. Chapter 9) 9.1) Deflection Problems Deflection fundamentals The electron beams in the CRT need to be scanned horizontally and vertically in a very precise manner to produce a raster - and a picture. For NTSC and PAL, the horizontal scan rates are 15,734 and 15,625 Hz respectively. For NTSC and PAL, the vertical scan rates are 60 and 50 Hz (approximately) respectively. The deflection yoke includes sets of coils for horizontal and vertical scanning oriented at 90 degrees with respect to each other. Additional coils are needed to correct for pincushion and other geometric defects. The deflection circuits must be synchronized and phase locked to the incoming video signal. Therefore, we have the following functions: Sync separator to obtain horizontal and vertical synchronization pulses. Horizontal oscillator which locks to horizontal sync pulses. Horizontal drive followed by horizontal output which feeds deflection yoke (and flyback for HV and other voltages), Yoke requires a sawtooth current waveform for linear horizontal deflection. Horizontal output in all but the smaller TVs is a large discrete power transistor, most often an NPN bipolar type. Vertical oscillator which locks to vertical sync pulses. sawtooth waveform for linear vertical deflection. Yoke requires Vertical drive/output which feeds vertical deflection yoke. use ICs for vertical drive and output. Newer TVs Various additional deflection signals to correct for the imperfections in the geometry of large angle deflection CRTs. These may be fed into the normal deflection coils and/or there may be separate coils mounted on the neck of the CRT. 9.2) Why are nearly all horizontal drivers circuits transformer coupled? One (probably secondary) reason is that this provides one of the isolation barriers between a line-connected HOT and flyback primary and the signal circuits of the TV. A more important rational is that a transformer is nice easy way of impedance matching the horizontal driver circuit (100s to 1000s of ohms) to the few ohm input impedance of the horizontal output transistor base which requires upwards of several amps for proper drive. A typical driver transformer may be in the 5-10:1 turns ratio representing 25-100:1 impedance ratio. A byproduct of all this is that it is almost impossible for a faulty driver stage to kill the HOT. 9.3) Picture squeezed in then died You were watching 'Knight Rider' reruns and all of a sudden, the picture squeezed in slowly from the right hand side. It squeezed in about 2 inches or so when the entire picture went dead - has remained like this since. Sound is fine, but no activity at all from the tube. Has it died? How much time, effort, and expense to fix? No, it's not dead, at least it certainly is not the picture tube. Your set probably didn't like Knight Rider - at least that episode! Seriously, how old is the set? Is it a totally solid state chassis or are there tubes in the deflection circuits? Is there any indication of light on the screen? Any indication of the 15735 Hz horizontal running at all? (You would normally hear the high pitch sound). Newer TVs almost always derive voltages for the sound circuits from the horizontal deflection but older hybrids may run the sound off of its own power. In any case, there is a problem in the horizontal deflection and you probably have no high voltage as well assuming no light on the screen. The fact that it squeezed in first indicates that a partial short or other fault may have developed in the horizontal deflection circuits - possibly the deflection yoke or flyback transformer. It could also have been a bad connection letting loose. Once it failed completely, the horizontal output transistor may have bought the farm or blown a fuse. 9.4) Horizontal deflection shutting down Confirm that the horizontal deflection is shutting down (along with the high voltage since it is derived from horizontal deflection: listen for the high pitched deflection whine, test for static on the screen, see if the CRT filaments are lit, turn up the brightness and/or screen control to see if you can get a raster) and then why: Power is failing to the horizontal output transistor - this could be due to a low voltage power supply problem, bad connection, etc. Base drive to the horizontal output transistor is failing - could be a fault in the horizontal oscillator or bad connection. Problem with the flyback transformer or its secondary loads (flyback may provide other power voltages). X-ray protection is activating - either due to excess HV or due to a fault in the X-ray protection circuitry. If the problem comes and goes erratically it sounds like a bad connection, especially if whacking has an effect. If it comes and goes periodically, then a component could be heating up and failing, then cooling, etc. 9.5) Horizontal lock lost A TV which loses horizontal lock when changing channels, momentarily losing the signal, or switching inputs may have a horizontal oscillator that is way out of adjustment or has drifted in frequency due to aging components. Note that the characteristics of this are distinctly different than for total loss of sync. In the latter case, the picture will drift sideways and/or up and down while with an off frequency oscillator, the torn up picture will try at least to remain stationary. This could be a capacitor or other similar part. Or, the oscillator frequency may just need to be tweaked (particularly with older sets). There may be an internal horizontal frequency adjustment - either a pot or a coil - which may need a slight tweak. If a coil, use a plastic alignment tool

a source for a new flyback would not hurt just in case. The arc most likely did damage the insulation internally which may or may not be a problem in the future. In some cases, the pinhole or crack is an indication of a more serious problem - overheating due to shorted windings in the flyback or excessive secondary load. First, clean the areas around the arc thoroughly and then try several layers of plastic electrical tape. If the TV works normally for say, an hour, then there is probably nothing else wrong and you can try for a proper sealing job or hope that tape holds out (put a few more layers on - each is good for about 8-10 KV theoretically). If the arc is from one of the sparkgaps around the CRT, this could also be a flyback problem indicating internal shorts in the focus/screen network. Once I had a TV where the main problem was a cracked flyback arcing but this took out one of the fusable resistors for the power supply to the VERTICAL output so the symptoms included a single horizontal line. Don't ask me to explain - replacing that resistor and the flyback (the flyback tested good, but this was for someone else) fixed the TV. In another case, a pinhole developed in the flyback casing probably due to poor plastic molding at the time of manufacture. This resulted in a most spectacular case of sparking to a nearby bracket. A few layers of electrical tape was all that was needed to affect a permanent repair. 10.9) Ozone smell and/or smoke from TV Smoking is just as bad for TVs as for people and usually more quickly terminal. White acrid smoke may indicate a failed electrolytic capacitor in the power supply probably in conjunction with a shorted rectifier. Needless to say, pull the plug at once. A visual inspection should be able to easily confirm the bad capacitor as it will probably be bulging and have condensed residue nearby. Check the rectifier diodes or bridge rectifier with an ohmmeter. Resistance across any pair of leads should be more than a few ohms in at least one direction. Remove from the circuit to confirm. Both the faulty diode(s) and capacitor should be replaced (though the capacitor may work well enough to test with new diode(s). If a visual inspection fails to identify the smoking part, you can probably plug the set in for a few seconds until the source of the smoke is obvious but be prepared to pull the plug in a real hurry. If the smell/smoke is coming from the flyback, then it has probably gone belly up. You may be able to see a crack or bulge in the case. While the flyback will definitely need to be replaced, it is likely that nothing else is wrong. However, it might be prudent to use a Variac when performing initial testing with the replacement just in case there is a secondary short circuit or excess HV problem. 10.10) Should I be worried about X-ray exposure while servicing a TV or monitor? The only source of X-rays in a modern TV or monitor is from the CRT. X-rays are generated when a high velocity electron bean strikes a heavy metal target. For anything you are likely to encounter, this can only happen in a vacuum - thus inside the CRT. The higher the voltage, the greater the velocity and potential danger. The thick front CRT faceplate protects users adequately but there may be some emission from the thinner sides. At 25-30 KV (quite low as X-ray energies go) X-rays will be stopped by almost any metal so what you have to worry about is where there are no shields. However, realistically, there is very little and I would not worry about exposure unless you plan to be sitting for hours on the sides, behind, or under the TV or monitor - with a picture (there will be none if the screen is black). 10.11) Flyback shot by 4 year old Your 4 year old son shot the Sony in the flyback transformer. Smoke and sparks everywhere. Great aim! Who says these FAQs cannot be funny? Needless to say, unplug the set immediately. Inspect around the target area for obviously blown or damaged components. Test fuses and fusable resistors. Repair burnt solder connections and circuit board traces. Once the set is entirely dried out, power it up - preferably through a series light bulb and/or Variac until you are sure nothing else will let loose. Look, listen, and smell for any unusual behavior. If it now works, then consider yourself lucky. If not, there may be damage to transistors, ICs, or other components. (The following from: (Richard Symonds)). We're seeing another 'hazard' these days, people cleaning their television screens with window cleaner - no problem in the days of separate chassis but with the entire p.c.b. jammed under the tube on most t.v.s these days just a few drips and its all over. Some have just corroded the switch banks (had one recently just got into the A/V switch - when you walked around the room the set changed to A/V and back by itself!) but a few have got around the microprocessors and surface mount components and resulted in complete write-offs. I suppose the damage is the opposite of electroplating as the microp's have constant voltage to them. Never mind, they'll be a good source of parts for future use. Chapter 11) 11.1) Raster, Color, and Video Problems No color - black and white picture This means absolutely no color - equivalent to a black and white picture. Not even a hint of color. First, confirm that the source is actually in color - try another channel or input device. Next, check the settings of the color control - it may have accidentally been turned down. If your TV has some kind of automatic picture mode, try turning if off and adjusting the color control. Try adjusting fine tuning if you have such a control and the problem is with a broadcast or cable transmission. At this point with a confirmed color signal source, there is a problem with the chroma circuitry. Note that to the average person, the obvious question becomes: is my color picture tube bad? The answer is a definitive NO. It is virtually impossible for a defective CRT to cause a total loss of color. A defective CRT can cause a lack of a primary color - R, G, or, B which will mess up the color but is not likely to result in a black and white picture. Some possibilities in no particular order: Weak signal or defect in tuner/IF causing loss of signal strength. Coler killer set too high (internal control) if it has one. Defective part around the chroma chip/circuit. Faulty color oscillator. Bad connections in area of chroma chip/circuit. Defective chroma chip (don't suspect this first just because it is probably very expensive). A service manual or SAMs, DMM, & scope will help greatly in attempting to troubleshoot this unless it is an obvious bad connection. Try prodding the main board around the chroma chip with an insulated tool to see if you can make the color come and go. I had one set where a $.02 resistor decided to open up causing just this problem - perfect BW picture, no color. Another had a coil with a broken wire. 11.2) Psychodelic color The means colors that are not normal and that adjustment of the user controls is not able to correct it so that all colors of the picture are properly displayed at the same time. For example, you are unable to get any yellows or blues in scenes that should have these colors.. Make sure the user color and tint controls have not been accidentally turned while cleaning or purposedly misadjusted by small (or large) kids. Perform the user setup described in the section: User picture adjustment. Confirm that the source is not a weird color video - try another channel or a tape. Verify that this is not a missing color problem - one of the primary R, G, or B, has disappeared. If so, refer to the section: Missing colors. Once these have been eliminated, you are left with the following possibilities: Defective part around the chroma chip/circuit. Misadjusted color oscillator. Bad connections in area of chroma chip/circuit. Defective chroma chip (don't suspect this first just because it is probably very expensive). A service manual or SAMs, DMM, & scope will help greatly in attempting to troubleshoot this unless it is an obvious bad connection. Try prodding the main board around the chroma chip with an insulated tool to see if you can restore normal color. Something as simple as a bad resistor or inductor can be the cause - don't immediately suspect the most expensive part. 11.3) TV and Monitor Manufacturing Quality and Cold Solder Joints Any intermittent problems with monitors that cause random sudden changes in the picture brightness, color, size, or position are often a result of bad connections. Bad solder joints are very common in TVs and monitors due both to poor quality manufacturing as well as to deterioration of the solder bond after numerous thermal cycles and components running at high temperature. Without knowing anything about the circuitry, it is usually possible to cure these problems by locating all bad solder connections and cleaning and reseating internal connectors. The term 'cold solder joint' strictly refers to a solder connection that was either not heated enough during manufacturing, was cooled too quickly, or where part pins were moved before the solder had a chance to solidify. A similar situation can develop over time with thermal cycling where parts are not properly fastened and are essentially being held in by the solder alone. Both situations are most common with the pins of large components like transformers, power transistors and power resistors, and large connectors. The pins of the components have a large thermal mass and may not get hot enough during manufacturing. Also, they are relatively massive and may flex the connection due to vibration or thermal expansion and contraction. To locate cold solder joints, use a strong light and magnifier and examine the pins of large components for hairline cracks in the solder around the pin. Gently wiggle the component if possible (with the power off). Any detectable movement at the joint indicates a problem. With the power on, gently prod the circuit board and suspect components with an insulated tool to see if the problem can be effected. When in doubt, resolder any suspicious connections. Some monitors may use double sided circuit boards which do not have plated through holes. In these cases, solder both top and bottom to be sure that the connections are solid. Use a large enough soldering iron to assure that your solder connection is solid. Put a bit of new solder with flux on every connection you touch up even if there was plenty of solder there before. 11.4) Intermittent or Missing Colors If gently whacking the set can make the color(s) come and go, then bad connections are a very likely possibility. The the effect is sudden - the color drops in and out instantly, it is not a CRT problem. If the color fades in and out with a delay of about 10-15 seconds, it is probably intermittent power to the CRT filament for that color and probably means a bad CRT since the three filaments are wired in parallel inside the CRT and one of the internal connections has come loose. Look in the neck of the CRT to make sure all three filaments are glowing orange. If one is out or goes on and off toss the set. Replacing the CRT is probably not worth it. However, if they all go on and off together (all colors would be fading in and out though perhaps not quite in unison), then bad connections on the video driver board (on the neck of the CRT) are indicated. Locate the output for the bad color on the video driver board on the neck of the CRT. This will probably read a significantly higher voltage than the corresponding pins for the good colors. A circuit problem is likely - probably on this board. Test components on this board for the good and bad color channels. shorted transistor or open resistor can kill one channel. Swap parts to confirm. A This is a catch-all for some of the most common TV and monitor problems. Most of the causes of intermittent colors boil down to bad connections of one form or another. For totally dead colors - not intermittent - bad components are also a possibility. Printed circuit board on the CRT neck. This is a common location for cold solder joints. Check with a bright light and magnifying glass for hairline cracks around the pins of larger parts. Prod and tap with an insulated tool to see if the problem is effected. Resolder if necessary. Cold solder joints elsewhere in TV or monitor usually around the pins of large parts such as transformers, power transistors and resistors, and internal connectors. Internal connectors that need to be cleaned and reseated. clean with contact cleaner, burnish, and replace. 11.5) Remove, Red, green, or blue full on - fog over picture This could be a heater-cathode (H-K) short in the CRT or a failure of a component in the chroma circuits or video output (driver board). Don't panic - heater-cathode shorts in CRTs can often be worked around. Some simple tests can confirm or rule out other possibilities. Compare the voltages for the video drive signals to the CRT on the little board on the neck of the CRT with the CRT both connected and unplugged. A schematic will help greatly in locating these signals. If there is a significant difference especially on the bad color, then the CRT is a likely candidate. Try tapping the neck of the CRT GENTLY (with it plugged in and while viewing a picture) to see if it is an intermittent problem. Might want to have eye protection on while doing this! If there is no significant difference, you may have a bad driver or a problem in the chroma circuits. Look for bad connection/cold solder joints, probably on the little board on the neck of the CRT. Use an insulated stick to gently prod the board and its components in an effort to induce/cure the problem. Look carefully for hairline cracks around the component leads. You can swap components between two colors and/or test with an ohmmeter on that driver board to determine what is bad. The nice thing about color monitors and TVs is that there three copies of each of these components. Swapping and/or comparisons between these is an excellent diagnostic technique. Alternatively, interchange the outputs of the bad color with a good one by jumpering on the video driver board (on the CRT neck). If the bad color changes, then the problem is in the circuitry and not the CRT. 11.6) Providing isolation for a CRT H-K short This procedure will substitute a winding of your own for the one that is built in to the flyback to isolate the shorted filament from the ground or voltage reference. Note that if you have a schematic and can determine where to disconnect the ground or voltage reference connection to the filament winding, try this instead. The flyback is the thing with the fat red wire coming out of it (and perhaps a couple of others going to the CRT board or it is near this component if your set has a separate tripler) and may have a couple of controls for focus and screen. It should have some exposed parts with a ferrite core about 1/2-3/4 diameter. The filament of the CRT is the internal heater for each gun - it is what glows orange when the set is on. What has happened is that a part of the fine wire of the bad color's filament (assuming this is indeed your problem) has shorted to the cathode - the part that actually emits the electrons. Normally, the heater circuit is grounded or tied to a reference voltage so when it shorts to the cathode, the cathode voltage level is pulled to ground or this reference. You will need some well insulated wire, fairly thick (say #18-22). Find a spot on the flyback where you can stick this around the core. Wrap two turns around the core and solder to the CRT filament pins after cutting the connections to the original filament source (scribe the traces on the board to break them). This winding should cause the filaments to glow about the same brightness as before but now isolated from ground. If they are too dim, put another turn on the flyback to boost the voltage. (Don't go overboard as you may blow the filament totally if you put too many turns on the core - you then toss the TV.) Route the wires so that there is no chance of them getting near the high voltage or any sharp metal edges etc. Your picture quality may be a tad lower than it was before because of the added stray capacitance of the filament wiring being attached to the the (formerly bad) video signal, but hey, something is better than nothing. 11.7) Rescuing a shorted CRT If the short is filament-cathode (H-K), you don't want to use the following approach since you may blow out the filament in the process. If this is the case, you may be able to float the filament and live with the short (see the section on: Red, green, or blue full on - fog over picture. Shorts in the CRT that are between directly accessible electrodes can be dealt with in a more direct way than for H-K shorts. At this point you have nothing to loose. A shorted CRT is not real useful. If the short is between two directly accessible electrodes like cathode-grid, then as a last resort, you might try zapping it with a charged capacitor. Start with a relatively small capacitor - say a few uF at a couple hundred volts. Check to see if the short is blown after each zap - few may be needed. Increase the capacitance if you fell lucky but have had little success with the small capacitor. If the fault is intermittent, you will, of course, need to catch the CRT with the socket disconnected and the short still present. Try some gentle tapping if necessary. If you do this with the charged capacitor across the suspect electrode, you WILL know when the short occurs! 11.8) Brightening an old CRT If performing adjustments of the internal background and/or screen controls still results in a dark picture even after a long warmup period, the CRT may simply be near the end of its useful life. In the old days of TVs with short lived CRTs, the CRT brightener was a common item (sold in every corner drugstore, it seemed!). You can the CRT seconds for the try a similar approach. CAUTION: this may shorten the life of - possibly quite dramatically (like it will blow in a couple of or minutes). However, if the monitor or TV is otherwise destined scrap heap, it is worth a try. The approach is simple: you are going to increase the voltage to the filaments of the electron guns making them run hotter. Hopefully, just hotter enough to increase the brightness without blowing them out. Voltage for the CRT filament is usually obtained from a couple of turns on the flyback transformer. It is usually easy to add an extra turn or two which will increase the voltage and thus the current making the filaments run hotter. This will also shorten the CRT life - perhaps rather drastically. However, if the monitor was headed for the dumpster anyhow, you have nothing to lose. There are also commercial CRT rejuvenators that supposedly zap the cathodes of the electron guns. A TV repair shop may be able to provide this service, though it is, at best, a short term fix. 11.9) Bleeding highlights On very bright areas of the picture, one or more colors may bleed to the right resulting in a trail of those colors. The difference between this problem and the section: Trailing lines in one or more colors is that in this case, only highlights are affected. One cause of this is that the color gain, contrast, or intensity controls (whatever they are called on your set) are set too high. See the section on: Color balance. Check the settings of any brightness limiter controls as well. 11.10) Trailing lines on one or more colors The following is from: (Ian White ()). Check the power supplies to the video circuits as well as the CRT filament (low heater volts can cause trailing). Also swap the the drives between the red and green guns (or whichever color is affected in your case) or the color output transistors. If the same color is always trailing then you can be certain it is the tube and it will need reactivating or see the dumpster. 11.11) Picture fades in and out If the picture faded away on the order of 10-20 seconds (and if it comes back, also comes up to full brightness in same time frame - possibly with the persuasion of some careful whacking) AND with NO other significant changes such as size, focus, etc., then take a look in the back of the tube for the filament to be lit - the orange glow near the CRT socket. If there is none, then you probably have a bad solder connection on the circuit board on the neck of the CRT. Look for fine cracks around pins on that board. Try prodding it with an insulating stick to see if the picture comes back. Resolder if necessary. It is probably not a bad CRT as the filaments are usually wired in parallel and all would not go bad at the same time. However, if only a single color fades in and out, then a bad connection inside the CRT is a distinct possibility - look for only one of the filament's glow to be coming and going. This is probably not worth fixing. If the picture faded away with other symptoms, then there is probably a fault in the video amplifier/output one of its power supplies still probably a loose connection if you are able to get it back by whacking. 11.12) Occasional brightness flashes These may last only a fraction of a scan line or much much longer. This could mean an intermittent fault in a variety of places including the video circuitry and SCREEN power supply: Brightness circuitry - SCREEN, master background or its power supply. Could be in or around flyback or focus/screen divider. Could perhaps be in the CRT, but probably less likely. Video amp before or at chroma demodulator - since after this point, you would most likely get colored flashes since only one of the RGB signals would likely be effected. If you get it from all sources, then tuner/IF is ruled out. Suppose you just have no signal to a direct video input. What do you get? If you still get flashes, it should be real easy to monitor either the video outputs or SCREEN supply (with a HV divider on your scope) for noise. Then trace back to power or noise source. 11.13) Excessive brightness and/or washed out picture Excessive brightness/washed out picture is often an indication of a problem with the SCREEN supply to the CRT. May be a bad capacitor or resistor divider often in the flyback transformer assembly or on the board on the neck of the CRT. If the excessive brightness just developed over time, then a simple adjustment of the SCREEN or background brightness controls may keep it (and you) happy for a long time. When good, a typical value would be in the 200-600 VDC at the CRT. The SCREEN (may be called master brightness or background) control should vary this. It could also be a problem with biasing of the video output transistors. There may individual controls for background brightness on the little board on the neck of the CRT. However, we are looking for a common problem since all colors are wrong in the same way. First, check for bad connections/cold solder joints by gently prodding with an insulating stick. Check voltages and bias levels. 11.14) Bad focus (fuzzy picture) Focus voltage on the CRT is usually in the range of 2-8 KV DC and should be controllable over a fairly wide range by the focus pot. The focus pot is usually located on the flyback transformer or on an auxiliary PCB nearby. The focus wire usually comes from the flyback or if the general area or from a terminal on a voltage multiplier module in some cases. It is usually a wire by itself going to the little board on the neck of the CRT. If a spark gap (a little 2 terminal device with a 1/8 gap in the middle) is arcing with power on, then the resistive divider has shorted inside the flyback, focus board, or HV multiplier - whatever you TV has - and the this unit will need to be replaced. Ditto if the SCREEN control affects focus and/or vice-versa. Using a suitable voltmeter (range at least 10KVDC), you should be able to measure it connected and disconnected. The ground return will be the outside coating of the CRT which may or may not be the same as the metal chassis parts. If the voltage is very low (less than 2K) and the pot has little effect: When measured right off of the source disconnected from the CRT circuit, then the problem is probably in the focus network in the flyback (or wherever it originates). Sometimes these can be disassembled and cleaned or repaired but usually requires replacement of the entire flyback or voltage multiplier. When measured with the CRT connected but reasonable with it disconnected, then check for a bad capacitor on the little circuit board. The CRT could also cause this but it is unlikely. 11.15) Focus drift with warmup or age Focus is controlled by a voltage of 2-8 KV DC usually derived from the flyback transformer and includes some resistors and capacitors. One of these could be changing value as it warms up. (assuming nothing else changes significantly as the unit warms up. E.g., the brightness does not decrease.) Focus is usually a separate wire running from the flyback or its neighborhood to the PCB on the neck of the CRT. Look for components in this general area. Use 'cold spray' to isolate the one that is drifting. If you have access to a high voltage meter, you should be able to see the voltage change as the TV or monitor warms up - and when you cool the faulty part. If it is in the flyback, then sometimes the part with the adjustments clips off and can be repaired or cleaned. Most often, you will need to replace the flyback as a unit. Focus voltage is derived from a subset of te high voltage winding on the flyback using a resistive voltage divider which includes the focus pot. These are extremely high value resistors - 200 M ohm is common - and so leakage of any kind can reduce or increase the focus voltage. All other things being ok - i.e., the picture is otherwise fine - I would suspect this type of failure rather than the CRT. If you have a high voltage meter, you can measure the focus voltage to determine if it is being changed by the focus pot and if it is in the ballpark (2-8 KV typical). Sometimes, the part of the flyback with the focus pot can be snapped off and cleaned or parts replaced but usually you need to replace the whole unit. There may a capacitor or two on the PCB on the neck of the CRT that could have increased leakage as well thus reducing the focus voltage. 11.16) Bad focus and adjustment changes brightness This is the classic symptom of a short between the focus and screen supplies - probably in focus/screen divider which is part of the flyback or tripler. If you have a high voltage meter, measuring the focus voltage will show that (1) it is low and (2) it is affected by the SCREEN control Similarly, the SCREEN voltage will be affected by the FOCUS control (which is what is changing the brightness. There is a slight possibility that this may be in the CRT as well. Measure the FOCUS and SCREEN voltage with a high voltage meter. If they are identical pull the plug on the CRT. If they are now their normal values, then a shorted CRT is a distinct possibility - see the section: Rescuing a shorted CRT. 11.17) Blank picture, good channel tuning and sound Since the tuner and sound are ok, horizontal deflection which usually generates power for most of the set is also working. Does 'blank picture' means a totally black screen with the brightness and contrast controls having no effect whatsoever? Or, is there is no picture but there is a raster - light on the screen? The direction in which troubleshooting should proceed differ significantly depending the answer. Here are some questions: As above, is there any light on the screen at any settings of the brightness and contrast controls, and/or when switching channels. Can you see any raster scanning lines? Can you hear the high pitched (15735 Hz) of the horizontal deflection? Looking in the back of the set, can you see the glow of the CRT filament? Do you get that static on the front of the tube that would indicate that there is high voltage? Any cracking or other normal or abnormal sounds or smells? Possible causes of no raster: no/low HV, drive to CRT bad/shut off as a result of fault elsewhere, blanking as a result of tuner/controller malfunction, filament to CRT not getting powered. Possible causes of no video: problem in video IF, video amplifiers, video output, cutoff due to other fault. It could be as simple as a bad connection - try gently prodding the boards with an insulated stick while watching the screen. Check for loose connectors and reseat all internal connectors. 11.18) Purple blob - or worse Have you tried demagnetizing it? Try powering it off for a half hour, then on. Repeat a couple of times. This should activate the internal degausser. See the section: Degaussing (demagnetizing) the CRT. Is there any chance that someone waved a magnet hear the tube? and/or move any items like monster speakers away from the set. Remove it Was your kid experimenting with nuclear explosives - an EMP would magnetize the CRT. Nearby lightening strikes may have a similar effect. If demagnetizing does not help, then it is possible that something shifted on the CRT - there are a variety of little magnets that are stuck on at the time of manufacture to adjust purity. There are also service adjustments but it is unlikely (though not impossible) that these would have shifted suddenly. This may be a task for a service shop but you can try your hand at it if you get the SAMs Photofact or service manual - don't attempt purity adjustments without one. If the set was dropped, then it is even possible that the internal shadowmask of the CRT has become distorted and you now have a hundred pound paper weight. It is even possible that this is a 'feature' complements of the manufacturer. If certain components like transformers and loudspeakers are of inferior design and/or are located too close to the CRT, they could have an effect on purity. Even if you did not notice the problem when the set was new, it might always have been marginal and now a discoloration is visible due to slight changes or movement of components over time. 11.19) Color TV only displays one color I assume that now you have no other colors at all - no picture and no raster. Let us say it is red - R. It is probably not the CRT. Do you have a scope? Check for the R, G, and B video signals at the CRT. You will probably find no signals for the defective colors. This is almost certainly a chroma circuit problem as any failure of the CRT or a video driver would cause it to lose a single color - the other two would be ok. Therefore, it is probably NOT the CRT or a driver on the little board on the neck of the CRT. Try turning up the SCREEN control to see if you can get a G and B raster just to confirm that the CRT is ok. Locate the video drive from the mainboard for the good and a bad color. Interchange them and see if the problem moves. If so, then there is a video signal problem. If not, it is on the little CRT board. It could be a defective chroma IC or something else in the chroma decoder. 11.20) Disappearing Red (or other color) Problem: I have been given an old colour TV. The reception is good, but very often, when the contrast and brightness of the TV image is low (e.g. when a night scene is shown), the red colour slowly disappears, leaving behind the green and blue image and many red lines. The remaining red retrace are the giveaway that this is most likely not a CRT problem. (If there were no red lines, it could be the filament for the red gun of the CRT going on and off due to a bad connection inside the CRT bad news.) How is a black and white picture? (Turn down the color control). If B/W picture is good, then the problem is somewhere back in the chroma decoder circuitry. Check the video input to the CRT video driver board and signals on that board. If B/W picture is also bad, then you can compare red and green signals to determine where they are becoming different. The red lines in your description sounds like the red video output circuit is drifting and messing up the background level, blanking, screen, or other setting. Could be a capacitor or other component. Chapter 12) 12.1) Tuner and AGC Problems No reception from antenna or cable Make sure your source is providing a signal and that the cable connectors are good (center pin not broken or bent). Try another TV if possible. Make sure you source select switch or mode is set correctly. may have accidentally set it to direct video or AUX input. Someone Are all bands affected? If so, the tuner or IF is faulty. If there is a lot of snow, then it is probably toward the front (circuitry wise) of the tuner. If it is just a black screen, then it could be in the IF or video amplifier. If only certain bands are bad - channels 2-6 for example, then certain parts of the tuner circuitry are faulty. However, make sure the CATV mode is set correctly as this affects reception on a band-by-band basis. The problems may be due to bad solder connections of the tuner shields, connectors, coils, and other components. Try prodding the tuner to see if you can make the problem come and go or at least change. 12.2) Picture is overloaded, washed out, or noisy This indicates an Automatic Gain Control (AGC) problem often caused by a dried up capacitor. You will probably need a schematic to go much further. This could be a problem in the tuner, IF, or video amplifiers. 12.3) Interference when using VCR RF connection (Some of these comments also apply to use of LaserDisc players, satellite receivers, video games, or other sources with RF modulator (Channel 3/4) outputs). This may consist of patterns or lines in the picture. If this only happens on the antenna or cable, it may be a problem with these sources or the tuner in the VCR rather than the TV. As a test, try the connecting the TV directly to the antenna or cable. If it only happens on cable, there may be a (temporary) problem with cable transmission - contact your cable company. If it happens on playback of good quality (commercial) recordings, then it could be a compatibility problem between the VCR and TV. Make sure your patch cable connections are secure and that the cables are not damaged - in particular that the center pin is intact. Try fine tuning if your TV has this capability. If this does not help, try switching the channel 3/4 selector on the VCR to the opposite position and try that channel, sometimes one will be better than the other particularly if one of these or an adjacent channel is active in your area. If you have RCA baseband video inputs on your TV, try this connection to the VCR. These should work better in any case. Confirm that it is not actually a problem with the VCR - try another TV if possible. If you just changed your component placement, the VCR or TV may be picking up interference from another component. Turn off everything but the VCR and TV and see if that identifies the culprit. Move the TV away from the VCR so see if they are interfering with each other - the TV may be introducing interference into the VCR. Occasionally, the particular patch cable or its length may affect reception quality - try another one. If none of this helps, you VCR's RF modulator may be bad or slightly weak. Alternatively, the tuner in the TV may be faulty. If reception is generally noisy on all sources, AGC or RF/IF alignment may need adjusting. However, not all tuners are created equal. Your TV may simply be making the best of a marginal situation. A light dimmer on the same circuit as the TV may result in similar symptoms. If you are tuning up your motorcycle (or automobile) in the same room, this may be spark ignition interference. 12.4) Missing or noisy channel or block of channels If you are unable to receive certain channels or blocks of channels, this is a tuner problem - could be as simple as bad connections - or even simpler:. First, check to see that the tuning mode is correct - TV, CATV, as this is the most common cause of channels 'disappearing'. TV channels are assigned frequencies ranging from 72 to almost 800 MHz depending on broadcast or cable channel assignment. To tune over such a wide range requires splitting it up into various bands even if these are not actually defined. If you have a varactor tuned set, then you already know about the Vl, Vh, and U bands which may use separate front-end components. Even modern quartz PLL synthesized tuners need to allocate circuitry depending on frequency range. Therefore, if a block channels is not working, it could be due to a failure of some component related to that frequency range. Aside from looking for bad connections, resoldering the shields and connector pins, prodding, pressing, praying, etc. you will need a schematic to have any chance of finding such a fault. There is another slight possibility. Some TVs have a parental lockout capability (pre V-chip) to prevent kids or other unauthorized access to selected channels. The channel selections may have been accidentally altered. Check your user manual for instructions on programming this feature. Even on models without this option, the same internal circuitry could be present but not normally accessible. A power surge or stray cosmic ray could have put the set in a screwy mode. Unplugging power for a minute or probably a much longer time might possibly reset such an anomaly. 12.5) Loss of Channel after Warmup If there is a general loss of picture and sound but there is light on the screen, then most likely the tuner or IF stage is pooping out. With both no sound and no picture but a raster and static, it is most likely a problem in the tuner, power to the tuner, or its controller (if non-knob type). If it recovers after being off for a while, then you need to try a cold spray in the tuner/controller to identify the component that is failing. Take appropriate safety precautions while working in there! If it stays broken, then most likely some component in the tuner, its controller, or its power supply as failed. There is a slight chance that it could be a bad solder connection - I have seen these in the tuner modules of RCAs on several occasions (and many other manufacturers - apparently not a solved manufacturing problem even after 40+ years! 12.6) Channel tuning drifts as set warms up This may be a slight drift - like someone is messing with the fine tuning or such a substantial change in tuning frequency that the channels go by as though you are surfing. Possible causes depend on tuner type: Quartz tuner (10 button direct access digital synthesizer) - For a slight drift, a component is probably changing value, possibly the crystal in the reference oscillator. For gross changes - flipping through channels - it is more likely to be a digital control problem the microcontroller is misdirecting the synthesizer to change frequency. Varactor tuner (buttons but not direct channel access) - If only a single pushbutton selection is the problem, the the varactor tuning diode for that button is probably changing capacitance. If all channels in a band (Vl, Vh, U) are having a problem, it is more likely to be a drifting D/A or faulty AFT (Automatic Fine Tuning) circuit or power supply. Turret or switch tuner (Knobs) - A component like a capacitor is changing value. You will have to get in there with a heat gun or cold spray and track it down the old fashioned way. At least, the problem is almost certainly localized to the tuner box (and possibly the controller if applicable). As noted, gradual slight changes in tuning are likely due to frequency determining components drifting. Uncontrolled channel surfing is probably a logic problem. For the quartz tuner, this could still be marginal connections causing the microprocessor to misdirect the synthesizer to change channels. For the latter case, particularly, the cause may still be bad connections resulting in loss of channel memory and/or erratic behavior. 12.7) Noise in picture and sound due to bright scene When a bright scene comes, the screen flashes and there is a lot of noise in the sound. When a dark scene comes, there is no flash or noise. Changing channel does not help. The noise persists even when the sound is muted. (The following is from: (Sam Lattuca)) When the video detector level is adjusted too high, you will get noise in the sound while screen contains a lot of white information (i.e. letters) but won't when only dark scenes are present. The video level adjust is usually a small coil normally located near the IF section. Since your set is several years old, this wouldn't be uncommon. It can be adjusted while watching the picture and listening to the sound. Chapter 13) 13.1) Audio Problems Picture fine, no audio First check that any muting control is not activated. This might be a button on the remote or set itself. If you have a headphone jack, it may have dirty contacts as plugging in a headphone usually mutes the speaker. If the set is mono or only one channel of a stereo set is out, then check for bad connections to the loudspeaker. Test the loudspeaker by disconnecting one of the wires (with the power off!) and measuring its resistance with an ohmmeter (it should be less than 100 ohms - probably less than 8 ohms). Or momentarily touch a 1.5 volt battery to the speaker terminals - you should get a click or pop from the speaker. Next, trace back from the speaker output terminals to the circuit board and look for bad solder connections or a loose or dirty connector. If these tests do not reveal anything, you probably need a scope (or audio signal tracer) and schematic. Or at least the part number off of the chip. Is the final amp a chip also or just a transistor? Have you tested the transistor? If there is little or no buzz from the speaker, that would indicate a problem fairly near the output. If the tuner/if were bad, I would expect some noise/humm pickup from the low level audio stages. Get the part number off of the chip. If it is in a socket, check the contacts for corrosion or looseness. 13.2) Weak or distorted audio Assuming you are not attempting to play it at ear shattering levels, this may be due to an alignment problem in the IF/audio demodulator, a bad audio IC or other circuitry, bad connection, or a defective speaker. If your TV has an earphone or audio line out jack, try this to see if it is clear. If so, then your problem is in the final audio amp or speaker(s). If only one channel of a stereo TV is affected, it is almost certainly the audio amp or speaker for that channel. Interchange connection to the two speakers temporarily and see if the problem moves. If the problem is at all intermittent - try gently whacking the TV - then it is likely a bad connection - either a cold solder joint or a dirty or tired IC socket. The audio amplifiers in newer TVs are almost always ICs and replacements are usually readily available. If the IC is in a socket, remove the IC, clean the pins and socket contacts and reinstall it. Sometimes, the contacts on old socket lose their springiness and do not provide solid connections. Such a socket will need to be replaced. If the set uses discrete transistors, it s also possible for one of these to become noisy. If your TV is fairly old - 10 years or so - this may be an alignment problem requiring tweaking of a coil in the sound IF. See your service manual. It may be possible to have similar problems with newer TVs but this is relatively rare. 13.3) Buzzing TV Do you actually mean buzz - low frequency as in 60 Hz? Or, do you really mean high pitched whine. If the latter, see the section: High pitched whine or squeal from inside TV. Is the buzz through the speaker or from the inside of the set? If it is the speaker, then it is a design issue with the audio circuitry. However, a buzzing that only occurs when the picture has sharply defined text or graphics, may be an overload problem at the source - some TVs simply handle it better than others. If it is from inside the set, it is in the deflection or power supply. There is a slight possibility that the AC power in your house has some harmonic content - the waveform is not sinusoidal. This might be the case if you try to run on the same circuit as an active dimmer or something else with thyristor control. Proximity to heavy industry could also cause this. In neither case can you infer the severity of this annoyance from specs. It is strictly a design (e.g. cost) issue. The size of the TV is not a strong indicator of the severity of the problem but there will be some relationship as the power levels are higher for larger sets. Possibly running on a slightly different line voltage may change it but that is not really an option. You could try a line conditioner (not just surge suppressor) which includes filtering. I suspect it won't make must difference. If it is in the audio circuits - from the speakers or line out - then consider using a (HiFi) VCR for the tuner with an external stereo amp and the internal speaker disabled. If it is noise from the TV, then the best you can do is audition various TVs very carefully to find one that you are satisfied with. BTW, when I got my new super duper RCA Colortrak in 1980, it had a similar annoying buzz - even had a repair guy out who behaved as though this was to be expected. I did get used to it and am not even aware of it today - and still use that set. 13.4) High pitched whine or squeal from TV with no other symptoms First, make sure it is not coming from the loudspeaker itself. If it is, then we are looking at an unusual electronic interference problem rather than simply mechanical vibration. There are several parts inside the TV that can potentially make this noise the horizontal flyback transformer and to a lesser extent, the deflection yoke would be my first candidates. In addition, transformers or chokes in the switching power supply if this is distinct from the horizontal deflection circuitry. I don't know about returning a set to a store that doesn't take refunds (I won't even ask about that!) but assuming that this sound level is normal for the particular model here are a couple of suggestions: You do not want to coat the TV as this may interfere with proper cooling, but the interior of the entertainment center cabinet could be lined with a non-flammable sounds absorbing material, perhaps acoustic ceiling tiles. Hopefully, not a lot of sound energy is coming from the front of the set. Move the TV out of a corner if that is where it is located - the corner will focus sound energy into the room. Anything soft like carpeting, drapes, etc. will do a good job of absorbing sound energy in this band. If you are desperate and want to check the inside of the set: It is possible to coat the flyback transformer, but this is used mostly when there a loose core or windings and you are getting not only the 15,735 Hz horizontal (NTSC) but also various subharmonics of this. This is probably acceptable but may increase the temperature of the flyback. Using appropriate safety precautions, you can try prodding the various suspect parts (flyback, deflection yoke, other transformers) with an insulated tool such as a dry wooden stick. Listen through a cardboard tube to try to localizing the source. If the sounds changes, you know what part to go after. Sometimes a replacement flyback will cure the problem unless it is a design flaw. You do not want to replace the yoke as convergence and other adjustments would need to be performed. Other transformers can be replaced. Note that the deflection frequency - just over 15 KHz for NTSC and PAL - is on the border of audible for adults but will likely be loud to younger people possibly to the point of being terribly annoying - or worse. If you are over 40 (men more so than women), you may not be able to hear the fundamental at all (at least you can look forward to silence in the future!). So, even sending the TV back for repair may be hopeless if the technician cannot hear what you are complaining about! Chapter 14) 14.1) Miscellaneous Problems General erratic behavior You press VOLUME UP and the channel changes or a setup menu appears all by itself just at the climax of your mystery story. Before you break out the screwdriver (or 12 pound hammer), cover up the IR remote sensor. Some types of electronic ballasted fluorescent lights may confuse the remote control receiver. Or, someone or something may be sitting on the remote hand unit or it may be defective and continuously issuing a bad command! Assuming this is not the source of the problem: Check for bad connections - see if gently whacking the TV makes any difference or triggers the errant behavior. Bad connections in the power supply, system controller, or tuner, may result in this sort of behavior. See the section: TV and monitor manufacturing quality and cold solder joints. There could also be noisy power, a defective bad microcontroller, or EEPROM. 14.2) Jittering or flickering due to problems with AC power If you have eliminated other possibilities such as electromagnetic interference from nearby equipment or a faulty video cable or problems with the video input (e.g., cable or VCR) - then noisy or fluctuating AC power may be a possibility. However, most modern TVs usually have well regulated power supplies so this is less common than it used to be. Then again, your TV may just be overly sensitive. It is also possible that some fault in its power supply regulator has resulted in it becoming more sensitive to small power fluctuations that are unavoidable. One way to determine if the problem is likely to be related to AC power is to run the TV on clean power in the same location connected to the same video input. For example, running it on an Uninterruptible Power Source (UPS) with the line cord pulled from the wall socket would be an excellent test. The output of the UPS's invertor should be free of any power line noise. If the TV's image has now settled down: Large appliances like air conditioners, refrigerator, or washing machines on the same circuit might cause significant power dips and spikes as they cycle. Plugging a table lamp into the same outlet may permit you to see any obvious fluctuations in power. What else is on the same circuit? Depending on how your house or apartment is wired, the same feed from the service panel may be supplying power to widely separated areas. For some unfathomable reason, your TV may just be more sensitive to something about the power from the circuit in that room. There may be nothing actually wrong, just different. While unlikely, a light dimmer on the same circuit could be producing line-conducted interference. If you have a multimeter, you could at least compare the voltages between the location where it has problems and the one where it is happy. Perhaps, the TV is sensitive to being on a slightly different voltage. This might only be a problem if some circuitry in the the TV is marginal in some resp

respect - the implosion hazard should not be minimized. A large CRT will have over 10 tons of air pressure attempting to crush it. Wear eye protection whenever dealing with the CRT. Handle the CRT by the front - not the neck or thin funnel shaped envelope. Don't just toss it in the garbage - it is a significant hazard. The vacuum can be safely released (let out? what does one do with a vacuum?) without spectacular effects by breaking the glass seal in the center of the CRT socket (may be hidden by the indexing plastic of the socket). Cover the entire CRT with a heavy blanket when doing this for additional protection. Once the vacuum is gone, it is just a big glass bottle though there may be some moderately hazardous materials in the phosphor coatings and of course, the glass and shadowmask will have many sharp edges if it is broken. In addition, there could be a nice surprise awaiting anyone disconnecting the HV wire - that CRT capacitance can hold a charge for quite a while. Since it is being scrapped, a screwdriver under the suction cap HV connector should suffice. The main power supply filter caps should have discharged on their own after any reasonable length of time (measured in terms of minutes, not days or years). Of course around here, TVs are just tossed intact which is fortunate for scavengers like me who would not be happy at all with pre-safed TVs! 15.1) An informal history of X-ray protection (The following is from: Marty). Most of the old tube type color TV sets used a shunt HV regulator tube, usually a 6BK4. If it failed, or some component in the HV circuit failed, the high voltage, normally 25KV, could go up to 35KV or more, causing some X-Ray leakage from the CRT. In the early 70s when news of this radiation scare was first announced, there was a public outcry to immediately fix the problem. The feds hastily imposed a requirement on manufacturers of TV sets to somehow render a TV set unwatchable if the HV exceeded rated limits. The manufacturers first response was to follow the letter of the law and the first HEW circuit simply blanked the video when the HV exceeded a setpoint to make the set unwatchable. It was quickly noticed that the HV was not turned off with this circuit and the CRT still could emit some radiation. Many TV sets with this feature were left on so the consumer could listen to the sound, so the feds tightened the requirement. By this time new TV sets were all solid state and some manufacturers experimented with HV shutdown circuits, but most of these circuits were poorly designed and not reliable. Zenith thought they had the answer by regulating the HV with a bank of 5 capacitors across the horizontal output transistor to hold down the HV to 25KV. If one capacitor opened, the HV would only rise about 2KV, not a dangerous situation. This wasn't good enough for the feds. The fix that Zenith finally came out with, was a 4 legged capacitor. Two legs were the emitter return for the horizontal output transistor, & two legs were the HV holddown capacitor (the equivalent value of the bank of 5 caps). This fix was accepted by HEW and millions of TVs were produced. It worked so well, that other manufacturers soon followed the lead (Magnavox, GE, etc.). Then the worst happened! The 4 legged monsters started failing in a large numbers. Not opening completely & not shorting out. They sometimes allowed the HV to skyrocket to over 50KV. Some of them even cut the necks off of the CRTs. Zenith issued a recall on those models with the problem (more than one entire model year). After several improved versions of the capacitor, the problem was fixed but that recall almost bankrupted the company. Other companies had failures too, but usually not as dramatic as Zenith's. Magnavox used the HV holddown capacitor, both single & 4 leg version in several 70s era TV sets and is a good candidate for fireworks as well. 15.2) Memory chips in TVs (From: Mark Zenier ( or )). Actually, they are EEPROMs. A modern TV has integrated the circuitry so that the microprocessor that controls it also sets the various adjustments like vertical height and other characteristics. The same memory that knows what channels are valid and what the brightness and other user adjustable settings are is used for factory adjustments that are set when the TV is first turned on. It's a lot cheaper to use the remote control signals that are already there than add a handful of trimmer resistors. For service purposes there is often a magic key sequence used with your remote control to access a service page in the on screen display than can change these. Since you can easily set something that could fry the various high power deflection circuits, getting a little too curious can void your warranty, and toast your set. 15.3) Tony's notes on setting convergence on delta gun CRTs (This section from: (A.R. Duell)) The older delta-gun tubes (3 guns in a triangle, not in a line) can give EXCELLENT pictures, with very good convergence, provided: You've set those 20-or-so presets correctly - a right pain as they interact to some extent. The CRT is set up in the final position - this type of tube is more sensitive to external fields than the PIL type. Both my delta-gun sets (a B&O 3200 chassis and a Barco CDCT2/51) have very clearly set out and labeled convergence panels, and you don't need a service manual to do them. The instructions in the Barco manual are something like: Apply crosshatch, and adjust the controls on the convergence board in the numbered order to converge the picture. The diagrams by each control show the effect. Here's a very quick guide to delta gun convergence where the settings are done using various adjustments on the neck of the CRT (if you don't have a service manual but do know what each control does, and where they all are otherwise, follow the instructions in the service manual -- sam): Apply a white crosshatch or dot pattern to the set. Don't try and converge on anything else - you'll go insane. It's useful to be able to switch between those 2 patterns. Before you start, set the height, width, linearity, pincushion, etc. They will interact with the convergence. Also check PSU voltages, and the EHT voltage if it's adjustable. That's where you do need a service manual, I guess. Turn off the blue gun using the A1 switch, and use the static radial controls to get a yellow crosshatch in screen. These controls may be electrical presets, or magnets on the radial convergence yoke (the Y-shaped deflection yoke). red and green the middle of the may be movable think behind the Turn on the blue gun and use the 2 blue static controls (radial and lateral) to align the blue and yellow crosshatches at the center of the screen. Some manufacturers recommend turning off the green gun when doing this, and aligning red with blue (using *only* the blue controls, of course), but I prefer to align blue with yellow, as it gives a check on the overall convergence of the tube. Turn off the blue gun again. Now the fun starts - dynamic convergence. The first adjustments align the red and green crosshatches near the edges I normally do the top and bottom first. There will be 2 controls for this, either a top and a bottom, or a shift and a linearity. The second type is a PAIN to do, as it's not uncommon for it to affect the static convergence. Getting the red and green verticals aligned near the edges is a similar process. You now have (hopefully) a yellow crosshatch over the entire screen. Now to align the blue. This is a lot worse, although the principle is the same. Turn on the blue gun again, and check the static (center) convergence To align the blue lines with the yellow ones, you'll find not only shift controls, but also slope controls. Use the shift controls to align the centers of the lines and the slope controls to get the endpoints right. These interact to some extent. You'll need to fiddle with the controls for a bit to work out what they do, even if you have the manual. The convergence over the entire screen should now be good.... A word of warning here... The purity is set by ring magnets on almost all colour CRTs, but on PIL tubes, there are other ring magnets as well like static convergence. Make sure you know what you are adjusting. 15.4) Saga and general setup for large CRT TVs (Responses from: Tony (), panic from V.K.) I'm having problem(s) with a brand new 40 Mitsubishi tube (direct view) TV. I'm writing this with hopes of getting some basic information so that the dealer doesn't bamboozle me. From first viewing (5 minutes after the delivery man departed). I noticed a discoloration patch in the top right hand corner (purple when the background is blue/greenish when background is white). As you probably know, a colour TV produces a red picture, a green picture and a blue picture on the screen at the same time. You eyes interpret that as a coloured picture. If you look at (a normal, non-projection) TV screen through a magnifying lens, you should be able to see red, green and blue dots, and no other colours. Now, there are 3 basic adjustments to getting a good colour picture : Purity. This means that the red picture is only red, the green picture only green, etc. This is the one that needs setting up on your set - you have a purity problem Convergence. This means that the 3 pictures line up over the entire screen (or as much of it as possible). If this one is wrong, you'll see coloured fringes around objects in the picture. Grey scale. This sets the overall colour of the picture - it means that white is really white, etc. It varies the relative intensities of the red, green and blue pictures. I called the store in a panic and they calmly told me to press the degauss button to eliminate the problem (which I quickly learned was spurious magnetization, caused perhaps by storage near a speaker in the warehouse?). Result? Better but not cured. Yes, spurious magnetization (or more correctly a different magnetic field around the tube from the one present when it was set up) will cause purity problems. The next day I visited the store, and the manager said (again) that this was an easily fixable problem, requiring a few waves of a degaussing coil. To appease me, he sends the salesman home with me with small (1 foot diameter) coil in tow. Salesman (boy, actually) waves the coil in front of and around set and can't seem to perfectly Argh... Here's what should have been done IMHO. The set should have been degaussed (a fancy word for demagnetized). They should have connected a 'pattern generator' to the set. This is a piece of equipment that generates various test signals. They should have selected 'red raster' (which will appear to you as a pure red screen), and set up the purity adjustments on that. You should ask to see the pure red raster (and pure green and pure blue if the generator will allow it), and make sure there are no strange-coloured patches. If you like, you can examine the screen through a magnifying lens to check that there are no dots of other colours appearing - I do that when I'm setting up a new TV or monitor. They should then have displayed a 'cross hatch' on the screen. This is a grid of white vertical and horizontal lines. Convergence errors are shown by the lines splitting into 2 or more colours (normally one of the 'primary colours' - red, green, or blue, and its complementary colour (cyan, magenta, and yellow)). Note, however, that it's VERY difficult or even impossible to get perfect convergence over the entire screen on a modern tube, and that you'll not notice small errors near the corners on a TV screen. Note that some engineers prefer to set up the convergence on some other type of display (dots, for example), but you should at least be able to see a cross hatch pattern (all pattern generators provide that one) They should have then displayed a 'grey scale' test display. This is a pattern of vertical grey bars of different brightnesses, from black to white. They should all have been a neutral grey, without colouration. Note that convergence and purity interact to some extent, and thus if either is adjusted, both must be checked (and rechecked). Grey scale adjustments interact with nothing else. I would want to see the set on a pattern generator (at least the patterns I've mentioned above) and identify the problems. To demagnetize the TV, he says that a large coil is required, that encompasses the whole unit; service rep will 'be in touch'. I've never heard of that - the correct procedure is to wipe the coil around the front, top, sides and bottom NOT the back and then move it 2-3m from the set before turning it off. It doesn't matter whether the set is on or off for this, btw. I've not heard of putting a large coil round the entire set. (See the section: Degaussing (demagnetizing) CRTs). After the sales boy leaves, I could SWEAR that the picture quality in general is decreased, with people (especially their extremities like lips and ears) appearing pinker than before, and also more general interference (fringes/noise) noticeable. The convergence and purity are set by ring magnets on the neck of the tube. It's possible that the degaussing procedure has slightly demagnetized these, and if so, the whole set will need to be set up. Similarly, if any part of the set was magnetized at the factory, then the adjustments may have been set up to compensate, and then after demagnetization, they'll need to be reset. So my questions are these. Can the original problem truly be FIXED with proper sized coil and application? I don't think the size of the coil will make any difference. I would want to see that set on a pattern generator, so I could be SURE as to what the problems are. If the dealers don't have a pattern generator, then they're not fit to be fixing TVs IMHO. Could I be imagining that the waving of the small coil degraded the picture quality? It's possible, but fairly unlikely. See above Should I demand replacement to a new set? Can I legally ask for this, or is it like a new car...you own it, now you deal with the service guys forever. I don't know US law, but in the UK, if a product is defective, you can demand a refund of the money paid (not a replacement or a repair, a refund). IMHO, a TV with incorrect colours is defective... 15.5) About Instant On TVs Most TVs built since, say, 1980 have only the microcontroller powered from a small transformer when the set is off. This permits the remote control or front panel pushbutton to switch the set on. This circuitry should be no more prone to catastrophic failure than what is in a VCR or digital clock. Historically, there were 'instant on' TVs which kept a substantial portion of their circuitry live all the time - especially those using vacuum tubes in at least part of the circuitry (other than the CRT). In these, there was a lot more to fail. Those tubes would continue to change their characteristics for many minutes when warming up. Circuits were also much more touchy - remember all that constant tweaking! Thus, it made sense from the users's perspective to eliminate the warmup period and keep those tubes toasty all the time. In modern solid state TVs, the only component to really need a warmup period is the CRT. All this means is that you have to wait 20 seconds for the picture to appear. 15.6) Can I add an S-Video input to my TV or VCR? Possibly, but why bother? VCR's circuitry anyhow. All S-Video means is: A special connector Separate luminance (Y) You will most likely be limited by the TV or Chrominance (C) rather than composite video. In a VCR, you will need to bypass the input circuitry and get to the place where Y and C are separate. This may or may not be possible depending on its design. In a TV, they may never be separate and you will need to substitute your own circuitry for the chroma demodulator. It is probably not worth it as you will likely not gain much in picture quality but if you really are determined, a schematic will be essential in either case. If all you want to do is allow for an S-video input, there are single chips which will combine the Y and C into a normal composite video signal. Also, see the section: How do I add A/V inputs to a TV which does not have them built in? since there may be safety implications in the case of adding S-Video to a TV without any A/V jacks. 15.7) How do I add A/V inputs to a TV which does not have them built in? The place to do this is after the video and audio IF where baseband signals are normally separate. Depending on the model of TV, this may be trivial to impossible - or a serious safety hazard. Trivial: many low-end models use the same chassis as the high end A/V receivers. Either there will a cable connection to the missing A/V panel, or a which would have the A/V interface and jacks. If your model, then it should be straightforward and circuits at that point. (read this: circuit board) be some parts missing, missing auxiliary board this is the case with safe to tap into the If, on the other hand, everything is crammed onto a single circuit board with no evidence of A/V signals, it may be very difficult as suitable tap-in points may simply not be available. Hazardous: many TVs have circuitry which is not isolated from the AC line. If this is the case with your set, then it may be more trouble than it is worth to provide the essential isolation barrier between the TV and your external A/V equipment. Unless you intend to always use the direct A/V inputs and forgo the tuner, you will need some way of selecting between them - a switch or relay. This could be manual - you push a button or flip a switch - or automatic. There are all kinds of ways to doing the detection - mechanical, checking for a low impedance connection, looking for a signal, using a switch, etc. You will need a schematic - don't attempt this without one (for safety, if no other reason). 15.8) Turning a TV (or monitor) into an oscilloscope? This question comes up so often and it does sound like a neat project to give a defunct TV a second life. Don't expect to end up with a Tek 465 on the cheap when you are done. However, it could be a fun learning experience. You will be severely limited in the performance of such a scope. TVs and monitors are designed to operate at a very narrow range of horizontal scan rates and the high voltage is usually derived from the horizontal deflection. So, you would need to retain the original deflection system for this purpose at least. You will need to disconnect the defection yoke from the horizontal and vertical deflection circuits of the TV or monitor without killing the HV. (also, doing all this without killing yourself as well). Depending on the design, this may be as simple as unplugging the yoke connector. More than likely, you will need to substitute a load for the horizontal deflection coil. A coil from another sacrificial similar TV or monitor would probably suffice. WARNING: at this point you have a really bright spot in the middle of the screen which will turn to a really black spot if the brightness is not turned way down really really quickly. For the horizontal, you need a ramped current source. You are driving a non-ideal inductor (the deflection coil) so it has both inductance and resistance. Thus the waveform is a trapezoid - a voltage ramp (for the resistive part) superimposed on a voltage step (for the inductive part). This should not be too difficult. Don't expect to be able to achieve really fast sweep. Even running at normal TV rates is non-trivial. Similarly, for the vertical you need to drive with a voltage (your signal) controlled current source. However, if you just screwing around, then the linearity etc. for the vertical may not be that important. In this case, one way is to put a current sensing resistor in series with the deflection coil and use this in a power op amp type of feedback arrangement. (You could do this for (2) as well. There is a good chance that the original brightness control will work as an intensity adjustment. However, with some TVs and monitors, this depends on receiving a valid video signal. You may need to improvise. If you do want to control the intensity from a signal source, you should be able to tap into the drive signals going to the little board on the neck of the CRT. Don't expect high bandwidth, uniform response, or any of the other things you take for granted with a decent scope. That takes work. However, as a fun project, this certainly qualifies. Interchanging the functions of the horizontal and vertical deflection yoke (and rotating it 90 degrees) may provide a better match of horizontal and vertical bandwidth to your intended applications or experiments. SAFETY: Once you disconnect the deflection yoke from the TV or monitor's circuits, move the original circuits out of the way and put a barrier between between you and the rest of the TV or monitor. All you will need are connections to the deflection yoke on the CRT (unless you want to do intensity modulation). With a color TV or monitor, such experiments could be pretty interesting but there may be color fringing effects since you are not compensating for certain aspects of dynamic convergence at all. 15.9) Displaying a video signal as a picture on an oscilloscope I am not sure why anyone would really want to do this other than as an experiment - it would be interesting one. If a composite video signal is the input, you will need a sync separator. You will have to construct a vertical deflection voltage ramp generator which can be locked to your vertical sync signal. The horizontal timebase of the scope will be fine for the horizontal deflection and should easily lock to your horizontal sync pulse or (if the scope has a TV trigger mode) directly to the video signal. A video amplifier will be needed if your Z axis does not have an internal amplifier (you need .7 V p-p to be full brightness range.) Unless you provide automatic gain control, this will need to include offset (brightness) and gain (contrast) adjustments. Even if there is an internal amplifier, it may not have the required bandwidth for the video signal. However, the overall brightness may be disappointing - a scope is not designed for overall high brightness. The beam focus will not be as good as that on a little TV either. 15.10) Use of surge suppressors and line filters Should you always use a surge suppressor outlet strip or line circuit? Sure, it shouldn't hurt. Just don't depend on these to provide protection under all circumstances. Some are better than others and the marketing blurb is at best of little help in making an informed selection. Product literature - unless it is backed up by testing from a reputable lab - is usually pretty useless and often confusing. Line filters can also be useful if power in you area is noisy or prone to spikes or dips. However, keep in mind that most well designed electronic equipment already includes both surge suppressors like MOVs as well as L-C line filters. More is not necessarily better but may move the point of failure to a readily accessible outlet strip rather than the innards of your equipment if damage occurs. Very effective protection is possible through the use of a UPS (Uninterruptible Power Supply) which always runs the equipment off its battery from the internal invertor (not all do). This provides very effective isolation power line problems as the battery acts as a huge capacitor. If something is damaged, it will likely be the UPS and not your expensive equipment. Another option is to use a constant voltage transformer (SOLA) which provides voltage regulation, line conditioning, and isolation from power spikes and surges. It is still best to unplug everything if the air raid sirens go off or you see an elephant wearing thick glasses running through the neighborhood (or an impending lightening storm). 15.11) GFCI tripping with monitor (or other high tech equipment) Ground Fault Circuit Interrupters (GFCIs) are very important for minimizing shock hazards in kitchens, bathrooms, outdoors and other potentially wet areas. They are now generally required by the NEC Code in these locations. However, what the GFCI detects to protect people - an imbalance in the currents in the Hot and Neutral wires caused possibly by someone touching a live conductor - may exist safely by design in high tech electronic equipment. The result - false tripping - is mostly a problem with 3 wire grounded devices with built in line filters having capacitors between Hot and Ground but may also occur with 2 wire ungrounded TVs due to the power-on surge into the highly capacitive or inductive loads of their power supplies. 15.12) Multisystem TVs The question often arise: can my NTSC TV modified to display PAL signals (or vice-versa). Unlike a VCR where there are substantial differences between recording of NTSC and PAL, the problem of displaying the picture is much simpler. The following assumes 525 line NTSC and 625 line PAL: The horizontal scan rates are nearly identical (15,734 Hz for NTSC and 15,625 Hz for PAL), so this is not likely to be a problem. If these differed significantly, then there would be design issues similar to those for multisync computer monitors and this would drive up cost. The vertical scan are slightly more of a problem with 525 line/60 Hz NTSC and 625 line/50 Hz PAL. But it is a lot easier to design vertical deflection to accommodate a modest variation in rates. TVs could be easily designed or modified to accept either. The color encoding techniques differ but inexpensive ICs exist that can deal with either standard. In fact, many are programmable to do either with a jumper and slight modifications to the external components. Displaying a monochrome - B/W - picture on the other kind of set is usually possible if the set has a vertical hold control or enough vertical range. Modifying the chroma circuitry is more complicated but it should be possible to substitute a second IC and patch it into the existing video chain. As far as commercial multisystem TVs are concerned, the real reason we do not see many of these (at least in the U.S.) is lack of demand. They are available if you look hard enough and are willing to pay a premium. They are readily available on the international market. 15.13) Could a TV be modified for 3D (stereo) display? The whole idea of stereo 3-D vision to put the left and right views to the appropriate eyeball. There are two common ways of doing this: Use different colors for the two views with color filters in front of each eye to separate the views. This is what were often used for the really bad (content wise) sci-fi movies of the '50s. Display alternate views on the same monitor screen but use LCD shutter glasses to allow each eye to only see the appropriate view. This requires increasing the refresh rate to avoid unacceptable flicker. The first approach can be used with any TV and a pair of monochrome video cameras. Of course, true color cannot be used since pure colored images are needed to separate the stereo views. Alternating views with synchronized LCD glasses is a possibility but on a standard TV, the resulting refresh rate would be 30 Hz with a 50% duty cycle which is likely to be useful only as a short experiment - else your viewers will likely develop splitting headaches. 15.14) Displaying TV on a computer monitor My general recommendation is that if you have the space, buy an inexpensive TV - the quality in the end may in fact be better. And, it will be usable without tying up your expensive monitor and (maybe) PC. While various convertors are advertized to use a computer monitor with video from a VCR or other source, keep in mind that if it sounds too good to be true, it probably is like the claim of a $200 box for this: OK, let me get this straight - this card/box will enable a 31.4 KHz horizontal scan rate monitor (VGA) be used as a TV - yes or no? It thus includes a video A/D, full screen frame buffer, D/A, and all the other tuner stuff for under $200? I don't think so. A scan doubler - which is a subset of the above will not result in a high quality picture since it will display pairs of lines interleaved. Or does the impressive advertisement leave out the key requirement that the monitor sync at the NTSC horizontal scan rate of 15.734 KHz (most newer monitor do not)? Or is it a board that plugs into a PC and indeed does use the resources of the PC including the VGA card and bus? In any case, get a written money back satisfaction guarantee. 15.15) Displaying computer video on a TV Assuming this means NTSC: You need to convert RGB to NTSC - there are single chips for this. Try Sony, Philips, Motorola, and others. These will combine the R, G, B, H sync, and V sync into a single composite video signal using a minimum of additional components. You need to match the scan rate to NTSC - 15.734 KHz horizontal. Even basic VGA is twice this - 31.4 KHz. If your video card can be programmed to put out interlaced NTSC rate video then this is easy. If not, it is more difficult. If you want to use anything higher res than VGA, it is a very non-trivial problem requiring the construction of a scan convertor which includes a video A/D, full frame store, interpolator/readout timing, video D/A. Unless you are an experienced digital/analog designer, you really do not want to tackle any of this. For the special case of VGA->NTSC, you may be able to get away with just storing a single scan line since the horizontal frequency is (almost) exactly twice the NTSC horizontal of 15.734 KHz. A double buffer where one buffer is storing while the other is reading out at approximately half the VGA pixel rate should work. With appropriate timing, even lines become the even field for NTSC and odd lines become the odd field (I may have this backwards). It is still not a trivial undertaking. Also, keep in mind that the quality you will get on NTSC will be poorer than the VGA due to fundamental NTSC bandwidth limitations. Also, flicker for line graphics will be significant due to the interlacing at 30 Hz. Even this is a non-trivial undertaking. The requirements for PAL are very similar. For 625 lines systems, the 800x600 is the format that most closely matches the TV resolution. You can also buy little boxes to do this. Quality is general not great as you are seriously limited by NTSC/PAL and the VCR. Except for presentations on existing TV rate equipment, it is probably not worth the effort. This is totally useless for any serious computer applications. For professional presentations, modern video projectors are available that use high resolution LCD panels and real-time scan conversion. However, they are quite expensive (up to $10,000!!!). 15.16) What is Kell factor with respect to interlaced displays? (The following is from Bob Myers ()). The Kell factor - which has to do with the fact that we're often undersampling an image from the standpoint of the Gospel According to St. Nyquist - IS a factor in the reduction of vertical resolution, but interlacing plays a part as well. This comes from at least two factors: The receiver usually cannot precisely interleave the two fields. More importantly, there are steps taken to reduce the interline flicker which reduce the effective vertical resolution. This includes running the line width of the display somewhat larger than would otherwise be the case, and in interlaced cameras, discharging the entire screen (including the lines from the other field) after every field scanned. Interlace is particularly troublesome on moving images, where you will often perceive momentarily missing details. There was a LOT of discussion regarding the gory details of interlacing in the recent HDTV debates within SMPTE and other groups. 15.17) Homemade V-chip (or at least viewing limiter Here is an interesting questions: I would like a control box of some sort that controls the cable signal that comes into the TV. I want to be able to control the total time a particular child has in his account to watch, plus the actual channels that he is allowed to watch (no Playboy or MTV), PLUS the time of day that he can watch (not during home work time). Programmable by channel, cumulative time, hour of the day, and day of the week. I also need a master pass word for parental programming of the kids accounts, plus be able to watch what I want to at any time. The kids could use either an individual account number or an individual card of some kind with a PIN like our ATM cards. This box should be secure so that a 14 year old boy can't bypass it very easily. At least without doing come major damage so that I'd know it when he did it. I know that this is a lot to ask, but I'm very familiar with computer programming and chipset technology, I do know that such a thing can be done. I just don't have the electronics knowledge to do it. The following probably won't help you build such a gizmo but here are some thoughts: First, I would not attempt to build any of the RF/cable switching stuff - there are too many variations. I would suggest trying to control the control of what you have. With a cable box, this would be relatively easy - just put the box and an IR transmitter in the same sealed enclosure. If you have only a cable ready TV, you could substitute or intercept the remote detector signal inside the set and disable the front panel controls. Then you need: An input devices - keypad for example. A display - a 1 line LCD. A microprocessor. This doesn't need to be much - just to store the 'account information' including balance, allowable channel and time slot map, passwords. It would need a real time clock. An IR remote code transmitter. This could probably be directly programmed by the micro to control your cable box. Each account would have a means of adding to the balance, password authentication, etc. You would have a superuser account for your own watching as well as changing any of the individual account settings. Too bad I don't still teach my intro to computer design courses - this would make a nice term project. If you have a junker PC, this would be a simple bit of programming (but quite wasteful of power even for an 8088 based PC). 15.18) Interesting TV Switch Mode Power Supply The following was found in a Sony TV: Q1 switching/reg transistor (+) ------+----------| |--------+----------| ---- | | --| _|_ AC ---| |--| = C1 | | diode /_\ D2 in ---| |------|---| +-----+------+ | | ---(-) | | Reg. Drive | C | D1 | +-----+------+ C choke +---- gnd | | C _|_ | | | +135 cap ___ C2 | | | I---> |+ +----------+---------+----------+---- + 135 Although at first this appears to short out the line supply, when drawn like this it turns out to be a valid switching regulator: Q1 is driven by a pulse width modulated signal a the horizontal rate. Q1 turns on putting 150 V across choke. Current ramps up in choke - more or less linear until saturation which should not occur. This time increases with increasing load. Q1 turns off. Since current in an inductor cannot change instantly, current continues to flow, now through D2, C2, and +135 load. LCR (R of load, diode) time constant - charges capacitor and powers load. It would appear to fail and run away under the following circumstances: Inductance is too low and choke cannot store enough energy even at high duty cycle to supply load. Too high a duty cycle and core saturates at which point transistor blows up. Inductance is too high relative to switching frequency so that choke does not have time to discharge (its current) before next current pulse DC current will just keep increasing until core saturates. This could only really happen if the switching frequency were too high for some reason unless someone changed core material or something like t. Load is too great due to fault elsewhere. When attempting to diagnose problems with these types of circuits where the natural outcome of a fault is for one or more expensive parts to fail catastrophically, it is wise to either use a Variac to bring up the input voltage slowly and carefully observe the behavior hopefully before too late or put a load in series with the line such as a 100W light bulb to limit the current (though this will change the behavior in various ways). 15.19) IR detector circuit This IR Detector may be used for testing of IR remote controls, CD player laserdiodes, and other low level near IR emitters. Component values are not critical. Purchase photodiode sensitive to near IR - 750-900 um or salvage from optocoupler or photosensor. Dead computer mice, not the furry kind, usually contain IR sensitive photodiodes. For convenience, use a 9V battery for power. Even a weak one will work fine. Construct so that LED does not illuminate the photodiode! The detected signal may be monitored at the collector of the transistor (Q1) with an oscilloscope. Vcc (+9 V) >-------+--------+ | | | \ / / R3 \ R1 \ 500 / 3.3K / \ __|__ | __/_ LED1 Visible LED __|__ | IR ---> _/__ PD1 +--------> Scope monitor point Sensor | | Photodiode | B |/ C +-------| Q1 2N3904 | |\ E \ | / R2 +--------> GND \ 27K | / | | | GND >--------+--------+ _|_ - Chapter 16) 16.1) International Color Television Standards Some questions and answers about TV standards (Responses from: Steve McKinty: ()) Q: What are the most common TV standards in the world? NTSC National Television Standards Committee PAL Phase Alternate Line SECAM SEquential Couleur Avec Memoire (Sequential colour with memory) There are other differences though. Strictly they are just different colour systems, but most countries which use PAL have 625 lines in a picture and send 25 full pictures/second, most NTSC countries have 525 lines and send 30 full pictures/second (mostly for historical rather than technical reasons). That complicates things. Q: Who devised them, and when? and why? Are they as old as television? The first serious TV experimenting was done in several countries around the period 1900-1930, mostly black & white. The BBC started a regular service in 1936, other countries followed soon after, but since the technology was developing very rapidly there were always improvements being made. The BBC started with 405 lines, the US started a service a couple of years later with 525, by the time other European countries started the technology allowed 625 lines. France even tried 819 lines. All those system were black & white, but people wanted to have colour. During the 1940's much of Europe was at war, and technological development for entertainment slowed down, but in the US they were able to continue and devised a colour system which was compatible with the existing black & white one. By compatible I mean that a black & white TV got a black & white picture, a colo(u)r one got a colour picture. No need to make people throw away their B&W TVs. This system was endorsed by the American National Television Standards Committee, and was named after it => NTSC. After the war other countries started to look at colour. NTSC was a very clever system, but it had some flaws. Engineers in various countries tried to improve on it, and Telefunken in Germany came up with a simple modification which improved colour stability. It was named PAL because they reversed the Phase of the colour signal on Alternate Lines. At the same time Henri de France, in France, fixed the same flaw in a different way. His design (SECAM) needed a memory inside the set which made it more expensive. PAL gave as good a result, so most countries opted for that. France stayed with SECAM, possibly because in the De Gaulle era of the 50's memories of German occupation were still fresh, and dropping a French system in favour of a German one would have been unpopular. Rumour has it that the French government subsidized Thompson to make memory affordable. Since Britain went PAL, France went SECAM, and the US went NTSC, any colonies or dependencies of those countries tended to get the same system. India/Pakistan got PAL, Algeria got SECAM, and since the US helped rebuild Japan after WW2 it got NTSC, etc. Q: What's the difference? To squeeze a colour signal into the same space as a black & white one, and stay compatible, the NTSC designers separated the colour and brightness information. The human eye is less sensitive to colour, so they were able to reduce the bandwidth of that signal (make it take up less space in each channel), 'hiding' it at the high-frequency end of the video. That meant they didn't need to make the channels bigger, and incompatible. To do that, they used the fact that you can represent most colours with a combination of Red, Green and Blue. If you film a scene with three cameras, one for each colour, then add all the outputs together you get a black & white image. This signal is called luminance, usually represented by 'Y'. Mathematically Y = R + G + B. (Actually, not all the contributions are equal). They then transmitted the Y signal just as for a black & white TV, and also transmitted the R and B in the extra colour signal. B&W TV's only saw Y, and colour TV's got Y, R and B. Since Y = R + B + G, G can be obtained as Y - (R+B), so they didn't need to transmit all three. To get both R and B into one signal, they use a combination of Phase and Amplitude modulation (think of it as AM and FM at the same time). Its called quadrature modulation, and works very well, but is susceptible to phase changes as it passes along cables, etc. If the signal gets +10 degrees phase change the colour will visibly change, which is why NTSC TV's have a tint control. PAL overcomes that by sending R and +B on one line, then R and -B on the next. That way a +10 phase shift on one line becomes -10 on the next, and small differences will cancel out. PAL TV's don't need tint controls. SECAM doesn't send both R & B together, it sends R on one line, B on the next. No fancy modulation, so no phase problems, but you need a 'memory' in the set to save up the signal from the previous line, since both R & B are required together for processing. Q: Why do you need different TVs? Mostly because of the different numbers of lines. Its quite easy to make one colour decoder which can cope with all the systems, but making a TV which can do 625 and 525 lines, 25 and 30 pictures/second, gets expensive. Consumers shop on price, no-one will buy a SECAM TV in the USA even if it only costs $20 more, since there aren't any SECAM channels. Q: Why do you need different VCRs? Q: Why can't one VCR record the same output? Some can, but like TVs it costs more to make them adjust. The motor speed varies with the number of pictures transmitted per second, for example. (This is covered in more detail in the document: Notes on the Diagnosis and Repair of Video Cassette Recorder (VCR) Notes on the VCR Failure Diagnosis and Repair.) Q: Why did different systems evolve? Q: Is one cheaper? Q: Is one better? When originally developed, expense was considered based on contemporary technology. As noted, politics may have been equally important. As to which has better quality, its all rather subjective. The 625-line system adopted in Europe has better vertical resolution than the 525-line US system, but some people find the 50Hz field rate still produces some flicker. NTSC/PAL/SECAM are all equally capable of excellent colour reproduction, but under poor signal conditions NTSC can degrade more quickly. Q: Are there other systems besides the ones I've mentioned? Why? Some others, like MAC where the colour and luminance are completely separated. That gets rid of interference (ever see the strange colours which appear on very fine check patterns?) but is more expensive and really only possible due to modern electronics. Q: Are there going to be more or less systems in the future? That is THE question! There are certainly going to be different systems, more lines, better sound, etc. Q: Is there any way to convert a PAL tape to NTSC or vice versa? Yes. If the PAL tape has 625 line pictures and the NTSC one has 525 line then you normally need a computer which can read in one format and re-adjust things. Not cheap, but becoming cheaper, several companies offer that sort of service. Some PAL VCRs can do a half-conversion, enough to fool most PAL TVs into thinking its got a PAL signal. Q: Do they teach this stuff in electrical engineering courses? Sometimes. 16.2) Some of it, depends a lot on the course and school. Politically Correct TV Standards (The following is from: Robert Rolf). SECAM Used by France and the former No tint control. No Full socialism. The should see, and how Soviet union. color control. state knows exactly what color you strong that color should be. PAL Used by Germany & UK, Australia etc. No tint control. A color control. Partial socialism. The state knows exactly what color you should see, but you get a choice as to how strong it can be. NTSC Used in USA and Canada, Japan etc. A tint control, A color control. Uncontrolled socialism. The state lets you chose what color you see and how strong it can be. They then tax you regardless. Just another way of looking at it.... 16.3) Variations on a 'standard' - the PAL system In the U.S., when PAL is mentioned, it is usually assumed to be 625 line/50 Hz as used in the UK and man other places. However, there are several variations on the PAL system. (The following from: Ed Ellers Learn troubleshooting and repair of CRT television from the technician work bench point of view Dear Electronic Repairer, CRT Television repair course is an E book covering all the major building blocks in CRT Television with emphasis given to real life scenario from the technician work bench and therefore provide a very good starting point for new students in electronics and also a reference book for those already in the field. The book is divided into two parts: Part one: is composed of 18 chapters of the major circuit blocks in CRT TV and explains basic functions and common problems associated with these blocks. Part Two: is composed of 10 chapters of pure real life repair histories from the technician work bench. The book is illustrated with numerous color photos to make the reader learn faster and get the concept pretty fast. Every Chapter is hyperlinked to the list of content for easy navigation within the book for those who decide to read the book directly from the computer screen. List of Content Chapter 1: Introduction to Television Repair Career Chapter 2: Component found in the Power supply (S.M.P.S) Chapter 3: Understanding S.M.P.S sub units Chapter 4: Solving power supply problems (s.m.p.s) using control IC. Chapter 5: Solving power supply problem for Television using transistor instead of control IC. Chapter 6: Understanding the Secondary power supplies Chapter 7: Main power fuse keep on blowing Chapter 8: Do it yourself series lamp current limiter Chapter 9: Using the series bulb for find shorted component on the primary supply Chapter 10: Understanding the Horizontal circuits Chapter 11: understanding fly back transformer Chapter 12: H.O.T getting shorted after replacement Chapter 13: Understanding and troubleshooting Color problems Chapter 14: Understanding and troubleshooting Vertical circuit Chapter 15: Understanding and troubleshooting the Audio circuit Chapter 16: Understanding and troubleshooting the Tuner circuit Chapter 17: Understanding and troubleshooting the micro processor Chapter 18: Understanding and troubleshooting the remote control Real life repair histories Chapter 19: LG Television NO Picture- Audio OK blue background Chapter 20: Panasonic TV model TC-14E1T with intermittent single horizontal line (blue) Chapter 21: Gold star TV vertical partially closed Chapter 22: Samsung Television dead Chapter 23: JVC 14'' DEAD after a voltage surge from a Generator Chapter 24: GLD TV Field Collapse with a single horizontal line Chapter 25: JVC Television Dead 21" Chapter 26: china TV with No Power symptoms Chapter 27: Sony TV 1902 GE.NO Picture NO sound only screen display i.e. channel Number Any problem downloading? don't panic just email me at humtechelectronics@gmail.com for assistance The book is currently on promotion at a special price of $29.95 Don't have credit card or paypal? worry not just send me an email at : humtechelectronics@gmail.com for details... This eBook comes with my full support...so if you have any issue just send me the Television model and Symptoms and there we go!!