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Servicing Monitors

WITH THIS ARTICLE WE BEGIN A SERIES ON SERVICING CRT-BASED MONITORS. MOSTLY, THIS REFERS TO COMPUTER MONITORS BUT THE INFORMATION APPLIES TO STUDIO VIDEO (RGB AND NTSC/PAL/SECAM) AND CCTV TYPES AS WELL.

Monitor technology has advanced significantly in the last few years. The good news is that newer models are cheaper, higher in performance, easier to use, and smarter than older ones. The bad news is that with many functions squeezed into integrated circuits and with schematics harder to obtain, repair of more esoteric problems can be a real nightmare. However, there are many, many common faults that can be dealt with using minimal test equipment and common tools.

Monitors, Monitors, and More Monitors

In the early days of small computers, a 110-baud teletype with a personal paper-tape reader was the "preferred" input/output device (meaning that this was a great improvement over punched cards and having to deal with the bozos in the computer room!).

The earliest true personal computers didn't come with a display—you connected them to the family TV. You and your kids shared the single TV, and the Flintstones often won out. The Commodore 64 would never have been as successful as it was if an expensive monitor had been a requirement rather than an option.

However, as computer performance improved, it quickly became clear that a dedicated display was essential. Even for simple text, a TV can only display 40 characters across the screen with any degree of clarity.

When the IBM PC was introduced, it came with a nice 80 × 25 green monochrome text display. It was bright, crisp, and stable. Mono graphics (MGA or MDA) was added at 720 × 350, CGA at a range of resolutions from 160 × 200 to 640 × 200 at 2 to 16 colors, and EGA extended things up to a spectacular resolution of 640 × 350. This was really fine until the introduction of Windows (well, at least once Windows stayed up long enough for you to care).

All of those displays used digital video—TTL signals that were coded for a specific discrete number of possible colors and intensities. Both the video adapter and the monitor were limited to 2, 4, 16, or a whopping 64 colors depending on the graphics standard. The video signals were logic bits—0s and 1s.

With the introduction of the VGA standard, personal computer graphics became "real." VGA and its successors—PGA, XGA, and all of the SVGA (non) standards use analog video—each of the R, G, and B signals is a continuous voltage that can represent a continuous range of intensities for each color. In principle, an analog monitor is capable of an unlimited number of possible colors and intensities. (In practice, unavoidable noise and limitations of the CRT restricts the actual number to an order of 64–256 distinguishable intensities for each channel.) Note that analog video was only new to the PC world. TVs and other video equipment, workstations, and image-analysis systems had used analog signals for many years prior to the PC's "discovery" of that approach. In all fairness, both the display adapter and monitor are more expensive, so it is not surprising that early PCs did not use analog video.

Most of the information in this series of articles applies to color computer video monitors and TV studio monitors as well as the display portions of television sets. Black and white, gray scale, and monochrome monitors use a subset of the circuitry (and generally at lower power levels) in color monitors so much of it applies to those as well.

For most descriptions of symptoms, testing, diagnosis, and repair, an auto-scan PC SVGA monitor is assumed. For a fixed frequency workstation monitor, studio video monitor, or closed circuit TV monitor, only a subset of the possible faults and procedures will apply.

Note: We use the term "auto-scan" to describe a monitor that accepts a wide (and possibly continuous) range of scan rates. Usually, that refers mostly to the horizontal frequency, as the vertical refresh rate is quite flexible on many monitors of all types. Fixed-scan or fixed-frequency monitors are designed to work with a single scan rate (though a 5% or so variation may actually be acceptable). Multi-scan monitors sync at two or more distinct scan rates. While not very common anymore, multi-scan monitors may still be found in some specific applications.

Monitor Fundamentals

Monitors designed for PCs, workstations, and studio video have many characteristics in common. Modern computer monitors share many similarities with TVs, but the auto-scan and high scan-rate deflection circuitry and more sophisticated power supplies complicates their servicing.

Currently, most computer monitors are still based on the Cathode Ray Tube (CRT) as the display device. However, handheld equipment, laptop computers, and the screens inside video projectors now use flat panel technology, mostly Liquid Crystal Displays—LCDs. LCD desktop displays have also recently begun to appear. Liquid crystal displays are a lot less bulky than CRTs, use less power, and have better geometry—but suffer from certain flaws.

First, the picture quality in terms of gray scale and color is generally inferior to a decent analog monitor. The number of distinct shades of gray or distinct colors is a lot more limited. They are generally not as responsive as CRTs when it comes to real-time video, which is becoming increasingly important with multimedia computers. Brightness is generally not as good as a decent CRT display. And last but not least, the cost is still much, much higher due both to the increased complexity of flat panel technology and lower production volumes (though this is certainly increasing dramatically). It is really hard to beat the simplicity of the shadow mask 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 into the dumpster than make it to product due to manufacturing imperfections.

However, a variety of technologies are currently competing for use in the flat-panel displays of the future. Among those are advanced LCD, plasma-discharge, and field-emission displays. Only time will tell which, if any, survives to become "the" picture-on-the-wall or notepad display—at reasonable cost. The DMD (Digital Multiple Mirror) approach from Texas Instruments is another interesting technology worth watching (no pun intended) especially for large screen displays.

Monitor Characteristics

The following describe the capabilities that characterize a display:

1. Resolution—the number of resolvable pixels on each line and the number of scanning lines. Bandwidth of the video source, cable, and monitor video amplifiers as well as CRT focus spot size are all critical. However, maximum resolution on a color CRT is limited by the dot/slot/line pitch of the CRT shadow/slot mask or aperture grille.

TODAY'S AUTO-SCAN MONITORS use digital controls—buttons (like on this IBM unit) and menus—for almost all adjustments.

2. Refresh rate—the number of complete images "painted" on the screen each second. Non-interlaced or progressive scanning posts the entire frame during each sweep from top to bottom. Interlaced scanning posts $^1/_2$ of the frame called a field—first the even field and then the odd field. That interleaving reduces the apparent flicker for a given display bandwidth when displaying smooth imagery, such as for TV. It is usually not acceptable for computer graphics, however, as thin horizontal lines tend to flicker at $^1/_2$ the vertical scan rate. The refresh rate is the predominant factor that affects the flicker of the display, though the persistence of the CRT phosphors are also a consideration. Long-persistence phosphors decrease flicker at the expense of smearing when the picture changes or moves. Vertical scan rate is equal to the refresh rate for non-interlaced monitors but is the twice the refresh rate for interlaced monitors (1 frame equals 2 fields). Non-interlaced vertical refresh rates of 70–75 Hz are considered desirable for computer displays. Television uses 25 or 30 Hz (frame rate) interlaced scanning in most countries.

3. Horizontal-scan rate—the frequency at which the electron beam(s) move across the screen. The horizontal-scan rate is often the limiting factor in supporting high refresh-rate, high-resolution displays. It is what may cause failure if scan-rate speed limits are exceeded due to the component stress levels in high-performance deflection systems.

4. Color or monochrome—a color monitor has a CRT with three electron guns each associated with a primary color—red, green, or blue. Nearly all visible colors can be created from a mix of primaries with suitable spectral characteristics using this additive color system. A monochrome monitor has a CRT with a single electron gun. However, the actual color of the display might be white, amber, green, or whatever single color is desired as determined by the phosphor of the CRT selected.

5. Digital or analog signal—a digital input can only assume a discrete number of states depending on how many bits are provided. A single bit input can only produce two levels—usually black or white (or amber, green, etc.). Four bits can display up to 16 colors (with a color monitor) or 16 shades of gray (with a monochrome monitor). Analog inputs allow for a theoretically unlimited number of possible gray levels or colors. However, physical limitations of the display, unavoidable noise, and other characteristics of the CRT—and ultimately, limitations in the psychovisual eye/brain system—will limit this to a practical maximum of 64–256 discernible levels for a gray-scale display or for each color channel.

Types of Monitors

Monitors can be classified into three general categories:

1. Studio video monitors—fixed scanning rate for the TV standards in the country in which they are used. They feature high quality, often high cost, utilitarian case (read: ugly), and an underscan option. Small closed-circuit TV monitors fall into the class. Input is usually composite video (*i.e.*, NTSC or PAL), although RGB types are available.

2. Fixed frequency RGB—high-resolution, fixed scan-rate units that are high quality, high cost, and offer a very stable display. Inputs are analog RGB using either separate BNC connectors or a 13W3 (Sun) connector. These often have multiple sync options. The BNC variety permit multiple monitors to be driven off of the same source by daisy-chaining. These monitors are generally used underscanned for computer workstation (*e.g.*, X-windows) applications so that the entire frame buffer is visible. There are also fixed-frequency monochrome monitors that may be digital or analog input using BNC, 13W3, or a special connector.

3. Multi scan or auto scan—these monitors support multiple resolutions and scan rates or multiple ranges of resolutions and scan rates. The quality and cost of these monitors ranges all over the

map. While cost is not a strict measure of picture quality and reliability, there is a strong correlation. Input is most often analog RGB, but some older monitors of this type (*e.g.*, Mitsubishi AUM1381) support a variety of digital (TTL) modes as well. A full complement of user controls permits adjustment of brightness, contrast, position, size, etc. to taste. Circuitry in the monitor identifies the video scan rate automatically and sets up the appropriate circuitry. With more sophisticated (and expensive) designs, the monitor automatically sets the appropriate parameters for user preferences from memory as well. The DB15 high density VGA connector is most common here, though BNCs may be used or may be present as an auxiliary (and better quality) input.

Why Auto Scan?

Thank IBM for this one. Since the PC has evolved over a period of 15 years, display adapters have changed and improved a number of times. With an open system, vendors with more vision (and willing to take more risks) than IBM were continuously coming up with improved higher resolution display adapters. With workstations and the Apple MacIntosh, the primary vendor can control most aspects of the hardware and software of the computer system. Not so with PCs. New improved hardware adapters that were not following any standards for the high-resolution modes (but attempted to be backward compatible with the original VGA as well as EGA and CGA) were being introduced regularly. Vast numbers of programs were written that were designed to directly control the CGA, EGA, and VGA hardware. Adapter cards could be designed to emulate those older modes on a fixed-frequency high-resolution monitor (and those exist to permit high-quality fixed scan-rate workstation monitors to be used on PCs). However, those would be (and are) much more expensive than basic display adapters that simply switch scan rates based on mode. Thus, auto-scan monitors evolved to accommodate the multiple resolutions that different programs required.

Ultimately, the fixed scan-rate monitor may reappear for PCs. Consider one simple fact: It is becoming cheaper to design and manufacture complex digital-processing hardware than to produce the reliable high-quality analog and power electronics needed for an auto-scan monitor. That is being done in the specialty market now. Eventually, the development of accelerated chipsets for graphics-mode emulation may be forced by the increasing popularity of flat panel displays—which are basically similar to fixed scan rate monitors in terms of their interfacing requirements.

Analog *vs.* Digital Monitors

There are two aspects of monitor design that can be described in terms of analog or digital characteristics:

1. The video inputs—early PC monitors, video display terminal (VDT) monitors, and mono workstation monitors use digital input signals that are usually TTL, but some very high-resolution monitors may use ECL instead.

2. The monitor control and user interface—originally, monitors all used knobs (sometimes quite a number of them) to control all functions like brightness, contrast, position, size, linearity, pincushion, convergence, etc. However, as the costs of digital circuitry came down—and the need to remember settings for multiple scan rates and resolutions arose—digital (microprocessor) control became an attractive alternative in terms of design, manufacturing costs, and user convenience. Now, most better quality monitors use digital controls—buttons and menus—for almost all adjustments except possibly brightness and contrast where knobs are still more convenient.

Since monitors with digital-signal inputs are almost extinct today except for specialized applications, it is usually safe to assume that "digital" monitor refers to the user interface and microprocessor control.

Interlacing

Whether a monitor runs interlaced or non-interlaced is almost always strictly a function of the video-source timing. The vertical sync pulse is offset an amount equal to $^1/_2$ the line time on alternate fields (vertical scans—two fields make up a frame when interlaced scanning is used).

Generally, a monitor that runs at a given resolution non-interlaced can run interlaced at a resolution with the same number of pixels per line but twice the number of lines vertically at roughly the same horizontal and vertical scan rates and video bandwidth (but half the frame rate). Alternatively, it might be possible to increase the resolution in both directions while keeping the horizontal scan rate the same, thus permitting a monitor to display the next larger size format. However, in this case, the video bandwidth will increase. Whether the image is usable at the higher resolution of course depends on many other factors (in addition to flicker) including the dot pitch of the CRT, video bandwidth of the video card and monitor video amplifiers, and cable quality and termination.

Monitor Performance

The ultimate perceived quality of your display is influenced by many aspects of the total video source/computer-cable-monitor system. Among them are:

1. Resolution of the video source—for a computer display, this is determined by the number of pixels on each visible scan line and the number of visible scan lines on the entire picture.

2. The pitch of the shadow mask or aperture grille of the CRT—the smallest color element on the face of the CRT is determined by the spacing of the groups of R, G, and B colors phosphors. The actual conversion from dot or line pitch to resolution differs slightly among dot or slot mask and aperture grille CRTs, but in general, the finer, the better—and more expensive. Typical television CRTs are rather coarse—0.75 mm might be a reasonable specification for a 20 inch set. High-resolution computer monitors may have dot pitches as small as 0.22 mm for a similar size screen. A rough indication of the maximum possible resolution of the CRT can be found by determining how many complete phosphor dot groups can fit across the visible part of the screen. Running at too high a resolution for a given CRT may result in *Moire*—an interference pattern that will manifest itself as contour lines in smooth bright areas of the picture. However, many factors influence to what extent that may be a problem.

3. Bandwidth of the video source or display card—use of high-performance video amplifiers or digital to analog converters.

4. Signal quality of the video source or display card—properly designed circuitry with adequate power supply filtering and high quality components.

5. Cables—high-quality cables with correct termination should be used. Also, cables should be as short as possible, and extensions or switch boxes should not be used unless they are designed specifically for high-bandwidth video.

6. Sharpness of focus—even if the

CRT dot pitch is very fine, a fuzzy scanning beam will result in a poor-quality picture.

7. Stability of the monitor electronics—well-regulated power supplies and low-noise shielded electronics contribute to a rock-solid image.

8. Anti-glare treatment of screen and ambient lighting conditions—no matter how good the monitor's electronics are, the display can still be washed out and difficult or tiring to view if there is annoying glare or reflections. The lighting and location are probably more important than how the screen itself is designed to minimize glare.

9. Electromagnetic interference—proximity to sources of magnetic fields and power-line noise can degrade the performance of any monitor, no matter how well shielded it is.

Performance Testing

Before we go further, here's a warning: No monitor is perfect. Running comprehensive tests on your monitor or one you are considering purchasing might make you aware of deficiencies you never realized were even possible. You might never be happy with any monitor for the rest of your life!

Also note that the intent of these tests is **not** to evaluate or calibrate a monitor for photometric accuracy. Rather they are for functional testing of the monitor's performance.

Obviously, the ideal situation is to be able to perform these tests before purchase. With a small customer-oriented store, that might be possible. However, the best that can be done when ordering by mail is to examine a similar model in a store for gross characteristics and then do a thorough test when your monitor arrives. The following should be evaluated:

- Screen size and general appearance
- Brightness and screen uniformity, purity and color saturation
- Stability
- Convergence
- Edge geometry
- Linearity
- Tilt
- Size and position control range
- Ghosting or trailing streaks
- Sharpness
- Moire
- Scan rate switching
- Acoustic noise

A document at my Web site (www.repairfaq.org) "Performance Testing of Computer and Video Monitors" provides detailed procedures for the evaluation of each of these criteria.

CAUTION: Since there is no risk-free way of evaluating the actual scan rate limits of a monitor, this is not an objective of those tests. It is assumed that the specifications of both the video source/card

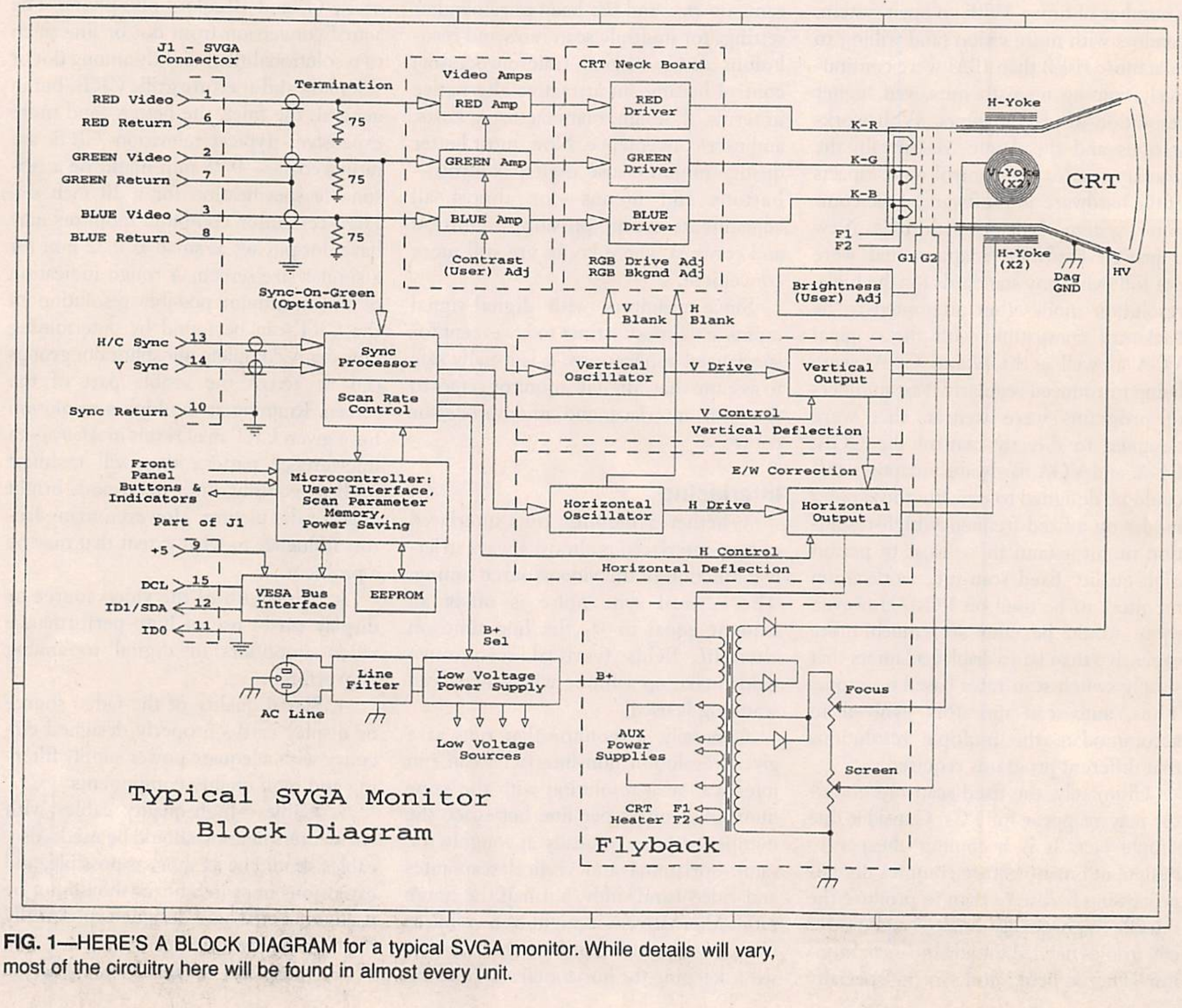

FIG. 1—HERE'S A BLOCK DIAGRAM for a typical SVGA monitor. While details will vary, most of the circuitry here will be found in almost every unit.

and the monitor are known and that supported scan rates are not exceeded. Some monitors will operate perfectly happily at well beyond the specified range, will shut down without damage, or will display an error message. Others will simply blow up instantly and require expensive repairs.

Monitor Repair

WARNING: The inside of a TV or monitor is no place for the careless or naive. If you are not sure of yourself or your knowledge, stay away. Unlike PC system boards where any disasters are likely to only affect your pocketbook, monitors can be very dangerous. Read, understand, and follow the set of safety guidelines that will be provided next month whenever working on TVs, monitors, or other similar high-voltage equipment.

If you do go inside, remember that line voltage (on large capacitors) and high voltage (on the CRT) could be present for a long time after the plug is pulled. There is the added danger of CRT implosion caused by carelessly dropped tools, and there are often sharp sheet-metal shields that could injure you if you should have a reflex reaction upon touching something you should not touch.

Having said that, a basic knowledge of how a monitor 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 monitor only displaying in black-and-white (this is probably a software or compatibility problem). The majority of consumers—and computer professionals—might not know even this simple fact.

This series will provide you with the knowledge to deal with a large percentage of the problems you are likely to encounter with your monitors. 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, for example, you decide to post your problem to the sci.electronics.repair newsgroup on the Internet. It will also be easier to do further research using a repair text such as the ones listed at the end of this month's column. In any case, you will have the satisfaction of knowing you did as much as you could before taking it in for professional repair.

Most Common Problems

The following probably account for 95% or more of the common monitor ailments:

- Intermittent changes in color, brightness, size, or position—bad connections inside the monitor or at the cable connection to the computer or video source.
- Ghosts, shadows, or streaks adjacent to vertical edges in the picture—problems with input-signal termination including use of cable extensions, excessively long cables, cheap or improperly made video cables, improper daisy-chaining of monitors, or problems in the video source or monitor circuitry.
- Color blotches or other color or distortion problems—these are caused by magnetization of the CRT. Locate and eliminate sources of magnetic fields if relevant and degauss the CRT.
- Wiggling, rippling, or other effects—electromagnetic Interference (EMI) is the culprit here. Nearby equipment (including and especially other monitors), power lines, or electrical wiring behind walls, may produce electromagnetic fields strong enough to cause noticeable distortion. Relocate the monitor or offending equipment. Shielding is difficult and expensive.
- Noise bars and similar effects—these are caused by noisy AC power reaching your monitor through the power cord. It is produced by such things as equipment using electric motors (*e.g.*, vacuum cleaners), lamp dimmers or motor-speed controls (shop tools), fluorescent lamps, and other high power devices. The source is likely local—in your house—but could be several miles away. The effects could be barely visible as a couple of jiggling scan lines or be broad bars of salt and pepper noise, snow, or distorted video. Plugging the monitor into another outlet or the use of a line filter could help. If possible, replace or repair the offending device.
- Monitor not locking on one or more video scan ranges—settings of the video adapter are incorrect. Use software setup program to set these. This could also be a fault in the video source or monitor dealing with the sync signals.
- Adjustments needed for background brightness or focus—as a CRT ages, its brightness is reduced. However, note that other components may affect focus. Fortunately, these can often be fixed using easy internal (or sometimes external) adjustments.
- Dead monitor due to power supply problems—very often the causes are simple such as bad connections, blown fuse or other component.

Repair or Replace

If you need to send or take the monitor to a service center, the repair could easily exceed half the cost of a new monitor. Service centers may charge up to $50 or more for providing an initial estimate of repair costs, but that will usually be credited toward the total cost of the repair.

Some places offer attractive flat rates for repairs involving anything but the CRT, yoke, and flyback. Such offers are attractive if the repair center is reputable. However, if by mail, you will be stuck with a tough decision if they find that one of these expensive components is actually bad.

Monitors become obsolete at a somewhat slower rate than most other electronic equipment. Therefore, unless you need the higher resolution and scan rates that newer monitors provide, repairing an older one may make sense as long as the CRT is in good condition (adequate brightness, no burn marks, good focus). However, if a monitor fails, it might just be a good excuse to upgrade.

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 2nd PC (or your 3rd or your 4th or . . .).

Monitors 101

Now that the preliminaries are out of the way, it is time to get to work. We'll begin by looking at the subsystems of a monitor. It will be helpful to refer to Fig. 1, which is a block diagram of a typical unit, as we proceed.

A computer or video monitor includes the following functional blocks:

1. Low voltage power supply: Most of the lower voltages used in the monitor may be derived from the horizontal deflection circuits (which we will look at next), a separate switching power supply, or a combination of the two. A rectifier/filter-capacitor/regulator circuit fed from the AC line provides the B+ to the switching power supply or horizontal-deflection system. Auto-scan monitors may have multiple outputs from the low voltage power supply that are selectively switched or enabled depending on the scan rate. The degauss circuit operates off of the line whenever power is turned on (after having been off for a few minutes) to demagnetize the CRT. Better monitors will have a degauss button that activates the circuitry as well since even rotating the monitor on its tilt-swivel base could make degaussing necessary.

2. Horizontal deflection: These circuits provide the waveforms needed to sweep the electron beam in the CRT across and back at anywhere from 15 kHz to over 100 kHz depending on scan rate and resolution. The horizontal sync pulse from the sync separator or the horizontal sync input locks the horizontal deflection to the video signal. Auto-scan monitors have sophisticated circuitry to permit the scanning range of horizontal deflection to be automatically varied over a wide range.

3. Vertical deflection: These circuits provide the waveforms needed to sweep the electron beam in the CRT from top to bottom and back at anywhere from 50 to 120 or more times per second. The vertical sync pulse from the sync separator or vertical sync input locks the vertical deflection to the video signal. Auto-scan monitors have additional circuitry to lock to a wide range of vertical scan rates.

4. CRT high voltage "flyback" power supply: A modern color CRT requires up to 30 kV for a crisp bright picture. Rather than having a totally separate power supply, most monitors derive the high voltage (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 pond. Some high-performance monitors use a separate high-voltage board or module that is a self contained high-frequency inverter.

5. Video amplifiers: These buffer the low-level inputs from the computer or video source. On monitors with TTL inputs (MGA, CGA, and EGA), a resistor network also combines the intensity and color signals in a kind of poor man's D/A. Analog video amplifiers will usually also include DC restore (black-level retention, back-porch clamping) circuitry to stabilize the black level on AC-coupled video systems.

6. 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 video amplifiers to the hundred volts or so needed to drive the cathodes (usually) of the CRT.

7. Sync processor: This accepts separate, composite, or "sync-on-green" signals to control the timing of the horizontal and vertical deflection systems. Where input is composite rather than separate H and V sync signals (as is used with VGA/SVGA), this circuit extracts the individual sync signals. For workstation monitors, which often have the sync combined with the green video signals, it needs to separate that as well. The output of the sync processor is horizontal and vertical sync pulses used to control the deflection circuits.

8. System control: Most higher-quality monitors use a microcontroller to perform all user interface and control functions from the front panel (and sometimes even from a remote control). So called "digital monitors"—meaning digital controls not digital inputs—use buttons for everything except possibly user brightness and contrast. Settings for horizontal and vertical size and position, pincushion, and color balance for each scan rate may be stored in non-volatile memory. The microprocessor also analyzes the input video timing and selects the appropriate scan range and components for the detected resolution. While these circuits rarely fail, if they do, debugging can be quite a treat.

Most problems occur in the horizontal deflection and power supply sections. Those run at relatively high power levels and some components run hot. This results in both wear and tear on the components as well as increased likelihood of bad connections developing from repeated thermal cycles. The high voltage section is prone to breakdown and arcing as a result of hairline cracks, humidity, dirt, *etc.*

The video circuitry is generally quite reliable. However, it seems that even after 15+ years, manufacturers still cannot turn out circuit boards that are free of bad solder connections or that do not develop them with time and use.

For More Information

For an on-line introduction to TV and monitor technology, check out the Philips/Magnavox Electronics Reference Web site (www.philipsmagnavox.com/product/pe33.html). 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. Specifically, see the article on the TV-set operating principles since a monitor is a high quality subset of a television receiver. (We will deal with TV sets in a future Service Clinic series.)

A number of organizations have compiled databases covering thousands of common problems with VCRs, TVs, computer monitors, and other electronics equipment. Most charge for their information but a few, accessible via the Internet, are either free or have a very minimal monthly or per-case fee. In other cases, a limited but still useful subset of the for-fee database is freely available.

A tech-tips database is a collection of problems and solutions accumulated by the organization providing the information or other sources based on actual repair experiences and case histories. Since the identical failures often occur at some point in a large percentage of a given model or product line, checking out a tech-tips database might quickly identify your problem and solution.

In that case, you can greatly simplify your troubleshooting or at least confirm a diagnosis before ordering parts. My only reservation with respect to tech-tips databases in general—this has nothing to do with any one in particular—is that symptoms can sometimes be deceiving and a solution that works in one instance might not apply to your specific problem. Therefore, an understanding of the hows and whys of the equipment along with some good old-fashioned testing is highly desirable to minimize the risk of replacing parts that turn out not to be bad.

The other disadvantage—at least from one point of view—is that you do not learn much by just following a procedure developed by others. There is no explanation of how the original diagnosis

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EQUIPMENT REPORT

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with holes for tripod mounting. The stand costs $149.95.

While not everybody needs a laser tool to align their speakers, audio professionals have long found laser levels to be useful. And this is "the" laser level for audio professionals who have had to make do with a carpenter's laser level all these years. But even the high-tech home-audio enthusiast might be able to justify the cost of this tool given its usefulness around the home. There are plenty of people out there doing all sorts of handyman projects where a laser level would surely come in handy. And when it comes time to align their speakers, those people will know that their speakers have been aligned with laser precision. All it takes is the SA-S Pro Sound Alignment System from Checkpoint Laser Tools. For more information on the SA-S Pro or the base model SA-S, contact the manufacturer directly at the address given earlier in this article, or circle 15 on the Free Information Card. **EN**

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was determined or what may have caused the failure in the first place. Nor is there likely to be any list of other components that may have been affected by overstress and therefore might fail in the future. Replacing Q701 and C725 might get your equipment going again, but that will not help you to repair a different model in the future.

Having said that, here are three tech-tips sites for computer monitors, TVs, and VCRs:

http://www.anatekcorp.com/techforum.htm (Free)
http://www.repairworld.com/ ($8/month)
http://elmswood.guernsey.net/ (Free, somewhat limited)

The following is just for monitors. Some portions are free, but others require a $5 charge. However, that might include a personal reply from a technician experienced with your monitor, so it could be well worth it:

http://www.netis.com/members/bcollins/monitor.htm

Some free monitor repair tips can be found at:

http://www.kmrtech.com/
http://www.metrosites.com/amr/monitor_repair_tips.htm

Tech-tips of the month and "ask a wizard" options are at:

http://members.tripod.com/~ADCC/ (Home page)
http://members.tripod.com/~ADCC/tips.htm (Tech-tips of the month)

The Resolve Monitor Tech-Tips database is a diskette that is priced out of the reach of most hobbyists. However, a reduced shareware version can be downloaded from a number of web sites. Go to http://www.filez.com/ and look for res16sw.zip.

Wrap Up

That's it for now. Next time we will begin to deal with monitor adjustment and troubleshooting, preceded by the most important safety information. Until then, check out my Web site, www.repairfaq.org. I welcome comments (via e-mail) of all types and will reply promptly to requests for information. See you next time! **EN**