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Display Symptoms, and More

WE CONTINUE THIS MONTH WITH SOME SPECIFIC DEFLECTION-RELATED PROBLEMS AND POSSIBLE CAUSES. WE WILL CONCLUDE WITH INFO ON DEFLECTION YOKE TESTING AND REPAIR.

Deflection Summary

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; the vertical scan rates are 60 and 50 Hz (approximately), respectively.

For PCs and workstation monitors, a wide range of scan rates are used. Some of the common ones are shown in Table 1. Even in high-resolution fixed-frequency monitors, those high horizontal-scan (in particular) rates necessitate some fancy circuit design. All components are running under stressful conditions, and it is amazing that failures are not more common.

With auto-scan monitors, the complexity of the circuits increases dramatically to accommodate the wide range of horizontal scan rates. Relays or electronic switches are used to select power-supply voltages, tuning components, and to make adjustments in the deflection circuits to handle DOS VGA one minute and Autocad 1280 × 1024 the next. It comes as no surprise that the most stressful time for a monitor may be when switching scan rates.

The deflection circuits must have the following characteristics:

1. Sync processor to provide separate H and V pulses to the deflection system.
2. Horizontal oscillator that locks to the horizontal sync pulses.
3. Horizontal drive followed by horizontal output, which feeds the deflection yoke (and flyback for HV and other voltages).
4. Vertical oscillator that locks to the vertical sync pulses.
5. Vertical drive/output that feeds the vertical deflection yoke.
6. Various additional deflection signals to correct for the imperfections in the geometry of large angle deflection CRTs.
7. Auto-scan deflection control and selection circuitry (auto-scan monitors only), probably controlled by a microprocessor that stores scan parameters for each scan rate and automatically detects the appropriate settings to use by analyzing the input video. Relays are often used for that selection since they are easy to control and can handle the voltages and currents in the various deflection circuits reliably.

Next, let's look at some common problems and their likely causes and solutions. To help you identify the symptom, some of the most common ones are shown in Fig. 1.

Monitor Display Is Off-Center

These sorts of problems usually relate to the picture shifting when switching between applications or between DOS and Windows. First, make sure you are using the correct monitor settings and video drivers.

If you have a setup program for your video card, make sure you are running well within the accepted scan rates for each resolution, and then toggle sync polarity and adjust H position or phase and see what these do.

Also make sure your cables are secure. While a bad connection would likely have messed things up worse, it won't hurt to check.

Size Or Position Problems At Certain Scan Rates

Here we are talking about large, noticeable problems. First, make sure you are not specifying an incorrect scan rate for your monitor. Check your video card setup and/or monitor selection in Windows.

Assuming you are not violating the scan-rate specifications but have a picture that is twice the height of the screen

TABLE 1—MONITOR SCAN RATES

Standard	Horizontal (kHz)	Vertical (Hz)
MDA	18.43	50
CGA	15.75	60
EGA	15.75-21.85	60
VGA	31.4	60-70
SVGA (800 × 600)	35-40	50-75+
SVGA (1024 × 768)	43-52+	43-75+
SVGA (1280 × 1024)	64-72+	60-75+
Workstations	64-102+	60-76+

and one half the width, for example, this could indicate a failure in the scan-rate switching circuitry of an auto-scan monitor. Either the logic is faulty and ordering the wrong selections for power-supply voltage and tuning components or the relays or other relevant parts are faulty. This could be due to bad connections as well—quite likely in fact. Also, try to reset the afflicted parameters using the digital controls (if your monitor has them) and then confirm that your video card is putting out the correct scan rate (try another monitor or examine the video signals with an oscilloscope).

Try prodding the circuit boards with an insulated stick—that could help identify bad connections or unstick a sticky relay.

If nothing helps, a schematic will likely be needed to proceed further with these sorts of problems.

Reduced Width

Older monitors often did not allow a full-screen display at certain resolutions. There may be underscan modes/switches as well. Keep in mind that advertising a large diagonal CRT does not necessarily imply that you can fill it!

However, if this problem just happened with no changes to your computer system (video card, scan rates, operating system), or are very severe (like ⅓ the width of the screen), then the following are possibilities:

- The B+ to the horizontal output is lower than normal.
- There could be problems in the scan rate switching circuitry.
- There might be a bad (low value or high ESR) decoupling capacitor.
- An open yoke winding (though this is less likely).

Damage Caused By Incorrect Or Missing Video

Mostly, there are problems at scan rates which exceed the monitor's specifications (low or high). However, too low a scan rate, an absent or corrupted signal input, or just a particular combination of events can blow some poorly designed monitors.

The specification that is likely to be more critical is the horizontal rate as it probably puts more stress on the components than the vertical rate. Attempting to determine the monitor's limits by experimentation can be very risky—it will be much too late when you find out. If the manual says 75 Hz V and 64 kHz H, stay below **both** of those specifications. If you exceed the safe ratings and the design isn't really good, there is the possibility of blowing components in the horizontal-deflection and high-voltage sections, which will result in expensive repair bills.

Note that you will likely get no warning of impending failure. In addition, even if the monitor does not immediately turn into a pile of smoking silicon and plastic, components may be under more stress and running at higher levels of power dissipation, so total failure could be just around the corner. More subtle degradation in performance could occur over time as well.

Most people won't see the difference beyond 75 Hz anyhow, and your programs may run slightly faster at lower scan rates because the video adapter will be using less memory bandwidth to refresh the screen.

Horizontal Deflection Shutting Down

Confirm that the horizontal deflection is shutting down along with the high voltage if it is derived from horizontal deflection. Listen for the high-pitched deflection whine (NTSC/PAL/CGA), test for static on the screen, see if the CRT filaments are lit, and turn up the brightness and/or screen control to see if you can get a raster. Some possibilities:

- 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 could be a bad connection, especially if whacking the unit has an effect. If the problem comes and goes periodically, then a component could be heating up and failing, then cooling, etc.

Monitor Non-Linearity

Most modern monitors are nearly perfect with respect to linearity. There are almost never any user adjustments and there may not even be any internal adjustments. A sudden change in linearity or a monitor that requires a warm-up period before linearity becomes acceptable may have a bad component—probably a capacitor in the horizontal-deflection circuits. In that case, try some cold spray or a heat gun to see if you can locate the bad part.

Vertical Squashed

Before attacking the circuitry, make sure your vertical scan rate is within the monitor's capabilities and that the user vertical-size control is adjusted properly. If there is no distortion, this is likely as many (but not all) circuit problems would result in non-linearity or cutoff of the top or bottom portions of the picture. All you may need to do is change your computer's video settings! Swap the monitor or computer to be sure it is not a problem with the video card.

However, if failure happened suddenly and the vertical is squashed at all scan rates, this is likely a vertical deflection problem—possibly a bad capacitor, bad connection, bad flyback/pump-up diode, or other component. None of these should be very expensive to replace (in a relative sort of way).

If the symptoms change—particularly if they become less severe—as the unit warms up, a dried out electrolytic capacitor is most likely to blame. If the symptoms get worse, the cause could be a bad semiconductor.

A defective deflection yoke is also possible or in rare cases, a bad yoke damping resistor (e.g., 500 ohms, may be mounted on the yoke assembly itself).

Keystone-Shaped Picture

This means that the size of the picture is not constant from top to bottom (width changes) or left to right (height changes). Note that some slight amount of keystoning is probably just within the manufacturing tolerance of the deflection yoke and factory set up. With a monitor, such defects are more noticeable than with a TV since much of the display is of rectangular boxes—*i.e.*, windows, lines of text, graphics, etc. Furthermore, the monitor is usually run just barely underscanned to maximize the viewing area without cutting anything off. Any deviations from perfection show up in relation to the CRT bezel. However, a sudden increase in the keystone effect could indicate a problem with the deflection yoke.

An open or short in a winding (or any

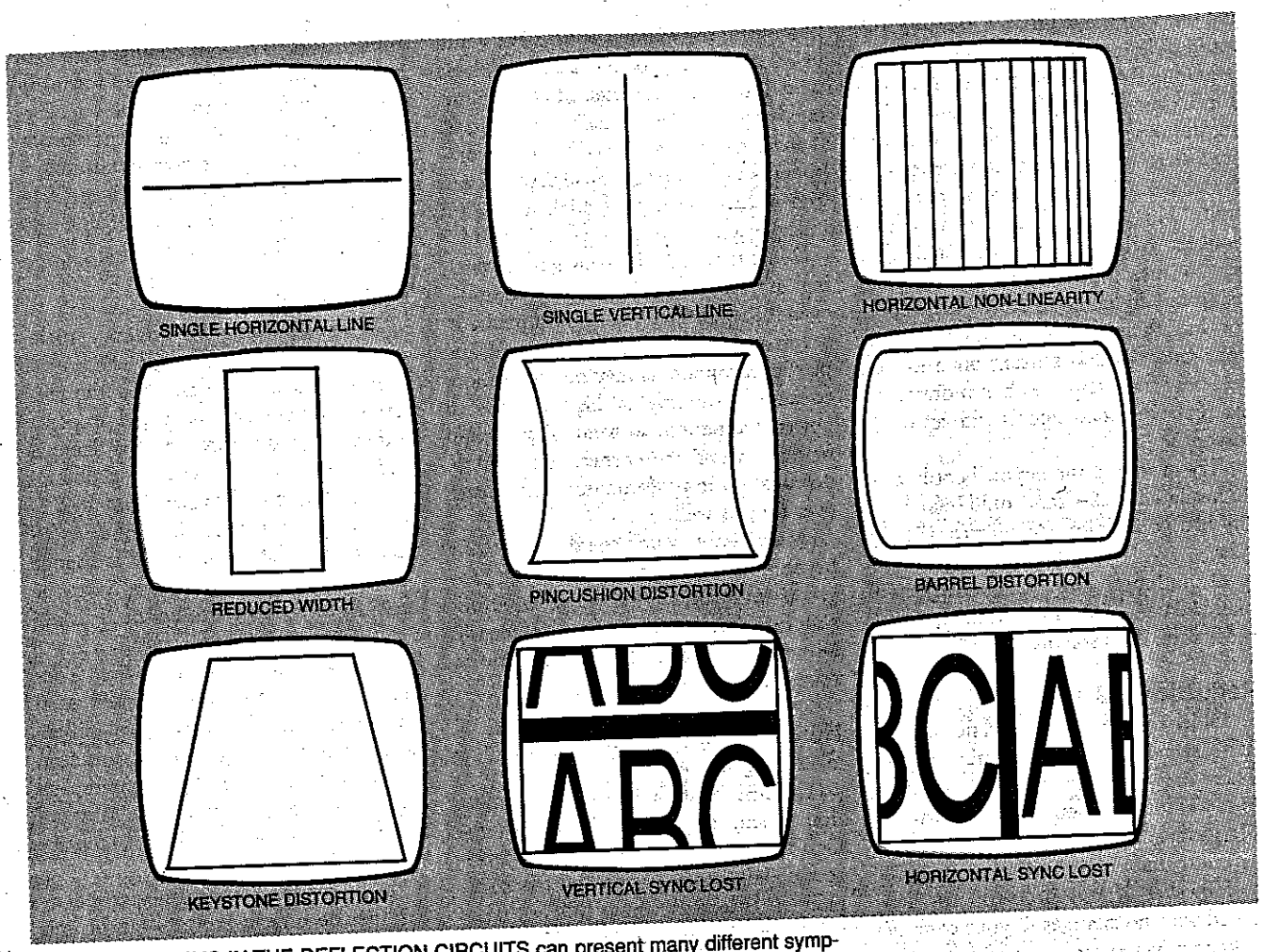

FIG. 1—PROBLEMS IN THE DEFLECTION CIRCUITS can present many different symptoms. Here are how some of the most common symptoms look.

associated components mounted on the yoke assembly) will result in the beam being deflected less strongly on the side where that winding is located. However, with a high-scan-rate monitor, there may be many individual windings connected in parallel in the yoke so the effect of only one opening up may not be as dramatic as with a TV where there may only be a single pair of windings for the horizontal and another for the vertical.

A simple test of the yoke in this case can be performed by swapping the connections to the yoke for the affected direction (*i.e.*, if the width changes from top to bottom, interchange the connections to the vertical windings). If the keystone shape remains the same (but of course the picture flips), it is likely the yoke. If the keystone shape flips, it is a circuit problem.

Monitor Will Not Sync

There are a wide variety of causes for a monitor that will not display a stable or properly configured image. First, check that the cable connections are correct and secure. If those are fine, we need to look at the specific symptoms. Among them are:

- Lack of horizontal sync—picture drifts smoothly horizontally: This may mean that the horizontal sync signal is missing due to a bent, pushed in, or broken connector pin; another bad connection; or a fault in the sync-processing circuitry. Note that depending on the difference between the video horizontal rate and the free-run frequency of the horizontal oscillator, the picture may be torn left or right or have multiple images superimposed horizontally—the diagram in Fig. 1 is the special case where they are virtually the same.
- Incorrect horizontal lock—torn picture (like a TV with the horizontal hold control misadjusted—if you remember those): This means that the sync signal is reaching the monitor but that it is having problem locking to it. Check the rate specifications—you may be exceeding them.
- Lack of vertical sync—picture rolls smoothly vertically: This may mean that the vertical sync signal is missing due to a bent, pushed in, or broken connector pin; another bad connection; or a fault in the sync-processing circuitry.
- Unstable vertical lock—picture jumps or vibrates vertically: This symptom could be due to scan-rate problems or a fault in the vertical-sync circuitry of the monitor.
- Multiple or repeated images (horizontally or vertically): There may be multiple images side-by-side, on top of each other, or interleaved. The most likely cause is driving the monitor with an incorrect scan rate. However, faulty circuitry could also be to blame if you see this symptom.

Bright Or Dark Bars

These are on the horizontal or vertical edge of the picture, and may be sharp-edged or blurry. The latter could result when a portion of the active video is unblanked during retrace.

Where the entire picture is present the video blanking is not occurring properly beyond the picture boundary.

Where part of the picture is cut off with a bright horizontal or vertical line at that point, it is either a video timing problem or a fault in the deflection circuitry preventing the beam from being where it is supposed to scan in enough time. You may be seeing part of the active video during retrace or as the beam reverses direction at the start or end of retrace. Horizontal timing problems would produce vertical bars on the right or left edge; vertical timing problems would produce horizontal bars at the top or bottom edge.

If your video card permits control of video timing parameters, try reducing the relevant active time relative to the blanking period. The relevant software settings might be horizontal position, phase, size, and sync polarity. If that does not help, your video card may be incompatible with the monitor.

If the problem just happened without any changes to the video source, the monitor may have a problem. Those could be in the:

- Deflection circuits: coil or capacitor, a power-supply fault, position or size settings or control, or deflection yoke.
- Video amplifier or drive (CRT neck board), or blanking circuits: chip decoupling capacitors or filter capacitors in scan-derived power supplies. If the bars are significantly colored—not just shades of gray—then a video problem is likely.

Single Vertical Or Horizontal Line

CAUTION: To prevent damage to the CRT phosphors, immediately turn down the brightness so the line is just barely visible. If the user controls do not have enough range, you will have to locate and adjust the master brightness or screen/G2 pots.

Since you have high voltage, the horizontal deflection circuits are almost certainly working (unless there is a separate high-voltage power supply—almost unheard of in modern TVs but possible in some higher performance monitors).

Check for bad solder connections between the main board and the deflection yoke. Could also be a bad horizontal coil in the yoke, linearity coil, etc. There is not that much to go bad based on these symptoms assuming the high voltage and the horizontal deflection use the same flyback. It is almost certainly not an IC or transistor that is bad.

A single horizontal line means that you have lost vertical deflection. High voltage is most likely fine since there is something on the screen.

This could be due to:

1. Dirty service switch contacts. Flip the switch back and forth a couple of times. If there is some change, then replace, clean, resolder, or even bypass it as appropriate.
2. Bad connection to deflection yoke or other parts in vertical output circuit.
3. Bad vertical deflection IC or transistor.
4. Other bad parts in vertical deflection circuit, though there are not that many parts that would kill the deflection entirely.
5. Loss of power to vertical deflection circuits. Check for blown fusible resistors/fuses and bad connections.
6. Loss of vertical oscillator or vertical drive signals.

The most likely possibilities are in the deflection output stage or bad connections to the yoke.

Intermittent Picture Jumping Or Jittering

This has all the classic symptoms of a loose connection internal to the TV or monitor, probably where the deflection yoke plugs into the main PC board or at the base of the flyback transformer. Gently whack the monitor and see if that has any effect.

It could also be a component momentarily breaking down in the power supply or deflection circuits.

Another possibility is that there is arcing or corona as a result of humid weather. That could trigger the power supply to shut down perhaps with a squeak, but there would probably be additional symptoms including partial loss of brightness or focus before it shuts down. You may also hear a sizzling sound accompanied by noise or snow in the picture, static in the sound, and/or a smell of ozone.

If your AC power fluctuates, an inexpensive monitor may not be sufficiently well regulated and may pass the fluctuations on as jitter. The video card is unlikely to be the cause of this jitter unless it correlates with computer (software) activity.

Vertical Foldover

This means that the picture is squashed vertically and a part of it may be flipped over and distorted. That symptom indicates a fault in the vertical-output circuit. If the TV or monitor uses an IC for that, then the chip could be bad. It could also be a bad capacitor or other component in this circuit.

To troubleshoot, test components in the vertical-output stage or substitute components with known good ones.

Barrel/Pincushion Distortion

Perfectly straight sides is not the natural state of affairs with linear-scan waveforms unless correction is applied. Normally, a signal from the vertical deflection that looks something like a rectified sinewave is used to modify width based on vertical position. There is usually a control to adjust the magnitude of this signal and often also its phase. So with excess (barrel distortion) or reduced (pincushion distortion) width, it would seem that this correction circuit has ceased to function.

If you have the schematics, check them for "pincushion" adjustments and check signals and voltages. If you don't have the schematics, try to find the "pincushion" magnitude and phase adjustments on the board and look for bad parts or bad connections in the general area.

If controls are present, then tracing the circuitry might be possible without a schematic. With luck, you have a bad part that is either open or shorted, and that can be easily found with an ohmmeter.

However, with modern digital setup adjustments, it is even tougher to diagnose problems. That's because the digital adjustments control a D/A converter that is located somewhere else and is linked via a microprocessor.

Deflection-Yoke Testing

A faulty deflection yoke can affect the geometry (size and shape) of the raster, result in insufficient high voltage and/or other auxiliary power problems, and blow various components in the low-voltage power supply or elsewhere.

Where high voltage (and other flyback-derived voltages) are reduced and other problems have been ruled out, unplugging the deflection yoke (assuming no interlock) may reveal whether it is likely at fault. If this results in some kind of improvement, a defective yoke is quite possible.

CAUTION: powering a TV or monitor with a disconnected yoke must be done with care for several reasons:

- The CRT electron beam(s) will not be deflected. If it turns out that the yoke is the problem, this may result in a very bright spot in the center of the screen

(which will turn into a very dark permanent spot quite quickly). Therefore, disconnecting only the winding that is suspect is better. Make sure the brightness and/or G2 (screen) is turned way down or disconnect the CRT filament if you don't need to see a picture.

• Removing the yoke (which is effectively in parallel with the flyback) increases the inductance and the peak flyback voltage on the HOT. In the extreme, this may blow the HOT if run at full line voltage/normal B+. It is better to perform these tests using a Variac at reduced line voltage if possible.

• The deflection system will be detuned since the yoke inductance plays a very significant role in setting the resonance point in most designs. Don't expect to see totally normal behavior with respect to high voltage. However, it should be much better than with the faulty yoke.

If possible, compare all measurements with a known good identical deflection yoke. Of course, if you have one, swapping is the fastest and surest test of all! In many cases, even a not-quite identical yoke will be close enough to provide useful information for testing. However, it must be from a similar piece of equipment with similar specifications (size and scan range). Don't expect a color TV yoke to work in a high performance SVGA monitor!

Note: the substitute yoke doesn't have to be mounted on the CRT which would disturb purity and convergence adjustments but see the caution above about an undeflected beam

Once it is determined that the yoke is defective, we need to troubleshoot it to learn more about the nature of the defect and to see if it can be easily repaired.

The deflection yoke consists of the horizontal coils and vertical coils (wound on a ferrite core), and mounting structure. Little magnets or rubber/ferrite strips may be glued in strategic locations. DO NOT disturb them! In rare instances, there may be additional coils or other components mounted on the same assembly. The following deals only with the actual deflection coils themselves—the other components (if any) can be tested in a similar manner.

The horizontal section consists of an even number of windings hooked up in parallel/interleaved with half of the windings on each of the two ferrite core pieces. The horizontal windings will be oriented with the coil's axis vertical and mounted on the inside of the yoke (against the CRT neck/funnel). They may be wound with thicker wire than that used for the vertical windings.

The first step in troubleshooting is to do a resistance check. That might be possible without removing the yoke from the CRT if the terminal block is accessible. Disconnect the individual windings from each other and determine if the resistances are nearly equal. Check for shorts between windings and between the horizontal and vertical windings as well. Typical resistance of the intact windings (at the yoke connector assuming no other components): TV or NTSC/PAL monitor: a few ohms (3 ohms typical); SVGA monitor: less than an ohm (.5 ohms typical).

Next, perform a visual inspection. Look for charring or other evidence of insulation breakdown due to arcing or overheating. For the horizontal windings, this will require removing the yoke from the CRT since little if any of the windings are visible from the outside.

You also can perform a ring test. We will be discussing this with respect to the testing of flyback transformers in a future Service Clinic article.

The vertical section of the yoke is usually manufactured as a pair of windings wired in parallel (or maybe in series), though for high vertical-scan-rate monitors, multiple parallel/interleaved windings are also possible. The vertical windings will be oriented with the coil's axis horizontal and wound on the outside of the yoke. The wire used for the vertical windings may be thinner than that used for the horizontal windings.

As before, do a resistance check. That might be possible without removing the yoke from the CRT if the terminal block is accessible. Disconnect the individual windings from each other and determine if their resistances are nearly equal. Check for shorts between windings and between the horizontal and vertical windings as well. The typical resistance of the intact windings (at the yoke connector assuming no other components): TV or NTSC/PAL monitor: more than 10 ohms (15 ohms typical); SVGA monitor: at least a few ohms (5 ohms typical). Also perform a visual inspection: look for charring or other evidence of insulation breakdown due to arcing or overheating.

While a ring test could be done on the vertical windings as well, since they have significant resistance and very low Q, it may be of limited value.

Deflection-Yoke Repair

So you found a big black charred area in/on one of the yoke windings. What can be done? Is it possible to repair it? What about using it for testing to confirm that there are no other problems before ordering a new yoke?

If the damage is minor—only a few wires are involved, it may be possible to separate them from each other and the rest of the winding, thoroughly clean the area, and then insulate the wires with high temperature varnish. Then, check the resistances of each of the parallel/interleaved windings to make sure that you caught all the damage.

Simple plastic electrical tape can probably be used as insulation for testing purposes—it has worked for me—but would not likely survive very long as a permanent repair due to the possible high temperatures involved. A new yoke will almost certainly be needed.

Wrap Up

That's it for now. Next time we will continue our discussion of monitor troubleshooting and repair. Until then, check out my Web site, www.repairfaq.org. I welcome comments (via e-mail only please to sam@stdavids.picker.com) of all types and will reply promptly to requests for information. See you next time! EN