TCON Troubleshooting

Introduction

Beginning in the fall of 2008, Sony announced the availability of limited TCON replacement boards to service LCD panels beginning with certain models going back to 2006. For many years technicians have been asking about the availability of these components. In the relatively small percentage of units that experienced a failure of the TCON board, replacement of the entire LCD panel was mandatory. This is not only costly from a warranty standpoint but it also makes it near impossible to justify an out-of-warranty repair since the replacement LCD panel can easily cost 2/3 or more of the price of the entire television.

The reason why TCON assemblies have not been available in the past was due to the large amount of correction data stored within NVM data points located on the board. Tolerance issues during the manufacture of the LCD panels required white balance, gamma, and uniformity corrections to compensate for these inherent production issues. There are other items for correct panel operation but the above mentioned items are the most critical.

Over the years, panel tolerances have improved dramatically and variances in uniformity have been reduced to the point where a TCON loaded with average data results in a satisfactory picture when installed as a replacement on a panel. Most Sony television models also have white balance data located on the video process board. Although the TCON is loaded with data to properly white balance the panel, the ability to adjust white balance from the B boards is present to compensate for shifts in white balancing due to panel aging and this mainly involves color balance shifting of the fluorescent backlight lamps which tend to shift towards the magenta spectrum as they age.

The main issue with previous LCD panel designs was the uniformity adjustment data. Due to variances across the LCD panel it was impossible to achieve even white balance across the screen. For this reason, small zones across and down the LCD panel required individual white balance compensation. Without this correction the picture would have “blotches” of different color in sections of the screen. Better tolerances during manufacturing have reduced the reliance on this uniformity data and allows for the replacement of TCON boards with satisfactory results.

As mentioned in the beginning, not all LCD panels will have a TCON board available. This will mainly be determined by availability of components from the LCD panel vendor along with decisions by Sony based on sales quantity and failure history of the TCON assemblies. Most technicians have experienced the use of the LCD panel replacement manual. This manual was created to properly identify the type of LCD panel installed in a unit based on its serial number since some units changed to a different type of LCD panel during the manufacturing production. The plan is to use this document to also provide TCON information and whether one is available and, if available, which TCON is the proper replacement part for that particular panel.

LCD Panel Basics

LCD panels have steadily evolved over the last several years. New designs of the physical structure of the LCD crystals have greatly improved the contrast ratio and viewing angle. Quicker response times and increased refresh rates have helped to reduce the motion “smear” associated with LCD displays. Backlighting design has also aided in producing a picture with color temperatures to make the images as true as possible. With all these design improvements, one aspect of the LCD panel remains relatively the same: Processing of the video signal.

Figure 4-5 illustrates a typical LCD panel and the associated video processing circuits as found in the WAX3 chassis. The various formats and resolutions of video signals are processed on the BU1 board. All video signals exit the video processor in the native resolution of the LCD panel. In this design, the resolution is for a 1366 by 768 at 60HZ refresh rate panel. 48 horizontal lines are discarded to match up to the 720p resolution of the ATSC specifications so the video will exit as 720p.

The LCD panel used in this model processes 8-bit RGB video data. Before the video information can be sent to the TCON board it must be converted to a format that allows for practical and noise-free transmission. The large number of parallel lines to transmit the 8-bit RGB data would need to be sent on differential lines for noise reduction. This would require 48 lines just for the video. The TCON circuit also requires B+, ground connections, a communications bus, sync, and a clocking line transmitted differentially so we can see that up to 60 lines would be required for an 8-bit video signal and significantly more lines for a 10-bit processor. The practical way to transmit this information is to convert the parallel video data to a serial stream and this is accomplished by the Low-Voltage Differential Signaling (LVDS) transmitter.

The LVDS transmitter contains a circuit to serialize the parallel data. The parallel video information along with sync and clocking data are transmitted via twisted line pairs. Depending on the logic level, current is sent along one or the other of the twisted pair of wires. The receiving end of the wires is loaded with a resistor (usually around 100 to 120 ohms). The receiver detects the polarity of the voltage drop across the resistor to determine the logic level. The current level swings in the wire are about 3ma with a voltage differential of around 350mv. This allows for transmission of the video signal with minimal EMI.

The LVDS receiver on the TCON board converts the serialized data back to parallel. This data is processed by the timing control IC to allocate the RGB data into serial streams for processing by the LCD panel. The TCON transmits the pixel control data to the panel via flat, flexible circuit board cables which can number 2 or 4 depending on the bit rate and refresh timing of the panel. A 1366 X 768 panel requires about 180 lines to transmit control information and B+ from the TCON. This number of control lines is not even close to the number of horizontal or vertical rows of pixels so the LCD panel must use this information to further expand the ability to turn on each individual crystal. The process will be explained in the gate and source driver paragraphs.

All of this is accomplished by the TCON board. The term “TCON” is short for Timing Control. Other LCD panel manufacturers may have a different name for this particular circuit but the term used by Sony will always be TCON.

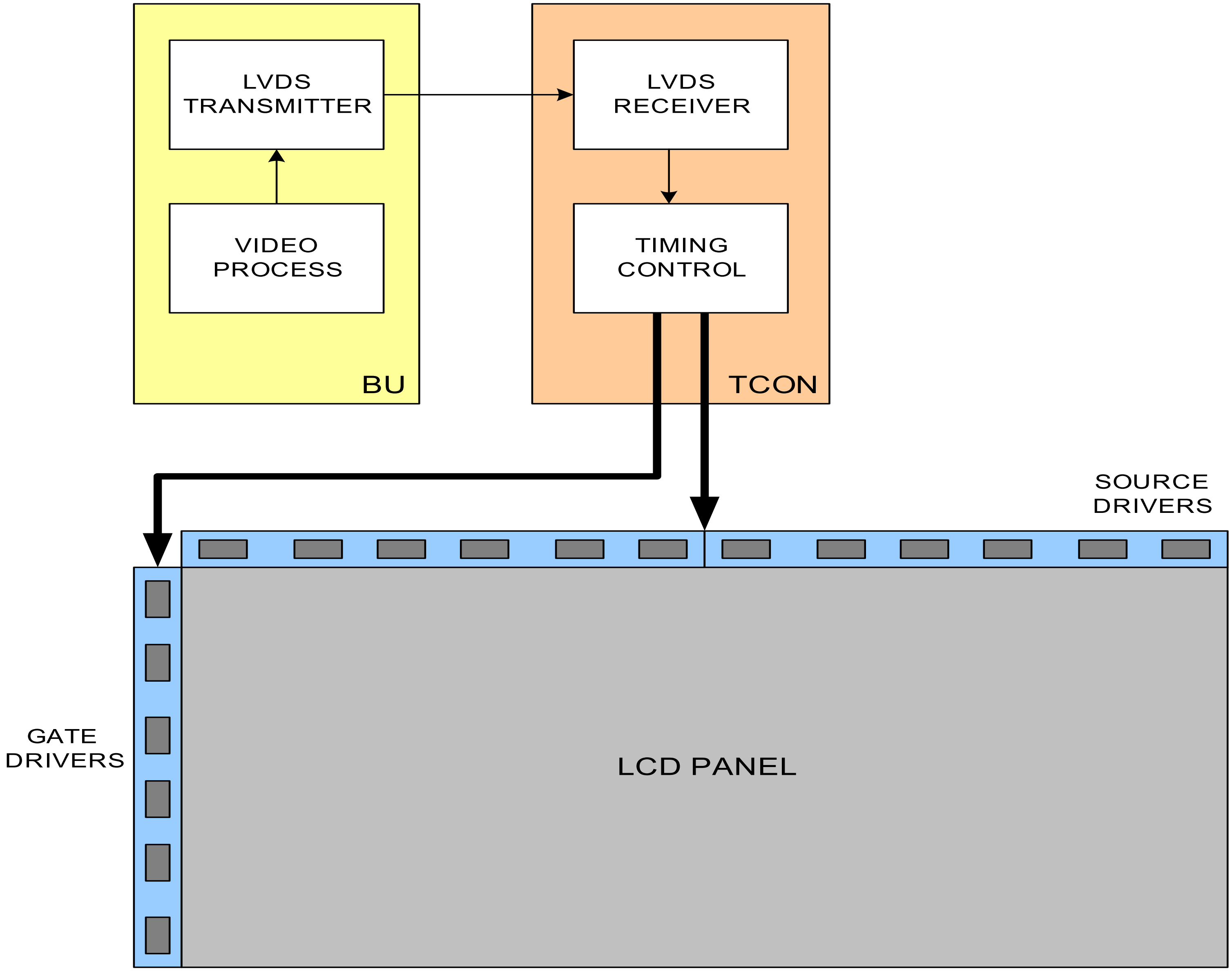


FIGURE 4-5
TYPICAL LCD TIMING CONTROL

Gate Drivers

Referring to Figure 4-5, note the IC's located along the side of the panel. These IC's are mounted on a flexible cable(s) which are bonded to the LCD panel. Their function is to activate each row of pixels one at a time starting with the first line at the top. As each line is activated, the source drivers turn on the appropriate liquid crystals for the frame of video about to be displayed. This continues from top to bottom until the entire frame of video is displayed. The process is repeated for the next frame. This rate can vary from 60 times per second or be increased to 120 or 240 as found in the high-frame-rate panels.

Source Drivers

These IC's provide the control voltages to turn on each RGB segment of the vertical rows of pixels. In this example, the panel has a horizontal resolution of 1366 pixels. Each pixel is made up of a red, green and blue liquid crystal which means there are 4,098 columns to control.

The source drive IC's contain shift registers along with buffer switches. Shift registers are used to convert serial data to parallel. By using this method, the TCON is able to transmit control information to each of the source drivers using serial data lines. If the TCON is transmitting 8-bit data to the panel, each data line is capable of controlling 256 lines exiting the source drivers. Understanding how the gate and source drivers work together makes it easier to observe a problem on the screen and determine if the failure is panel or TCON related.

Diagnosing a Failed TCON

In order for this concept to move forward successfully, it is important that the service industry be able to properly identify the symptoms of TCON issues to avoid unnecessary service calls and repair costs. Accurate analysis of TCON failures will reduce costs significantly (both in parts costs and time) when warranty repairs are involved and will reduce the number of COD repairs that are lost.

A good approach when determining a TCON failure is a good understanding of which symptoms ARE NOT caused by the TCON. Examples are as follows:

Video Process Failures: All video inputs received by the video process circuits are handled on a frame-by-frame basis. The video frames are converted and scaled to 8 or 10-bit RGB information. It is virtually impossible for the video process circuits to cause a problem on a specific area of the screen. Failures on this board usually appear as distortions, color level shifts, video level shifts, noise that involves the entire picture, or no picture at all. The TCON can generate symptoms that appear to be video process related but the video process circuits cannot produce the symptoms of a failed TCON circuit.

LVDS Cable Failures: Although problems with the LVDS cable or connectors can generate symptoms of TCON failures this usually tends to be intermittent and wiggling of the connectors will usually provoke a change in the symptom on the screen. LVDS cables and connectors have become rather robust over the past few years and most problems are caused by technicians who damage them and this is generally quite obvious upon close examination.

LCD Panel Failures: Some LCD panel failures could possibly be mistaken for TCON issues. Other than damage to the LCD glass, most panel failures are isolated to a particular area of the screen. Since the TCON disperses the pixel data to groups of line and column drive IC's situated on the outer edges of the panel, it is unlikely that more than one of these IC's would fail at the same time. Multiple columns of stuck on or stuck off pixels are, therefore, more likely to be the fault of the TCON circuits. The same applies to a single row of lit or unlit pixels. The TCON simply cannot cut out a single line of information. Figure 4-6 illustrates some typical symptoms of failures that are caused by the LCD panel.

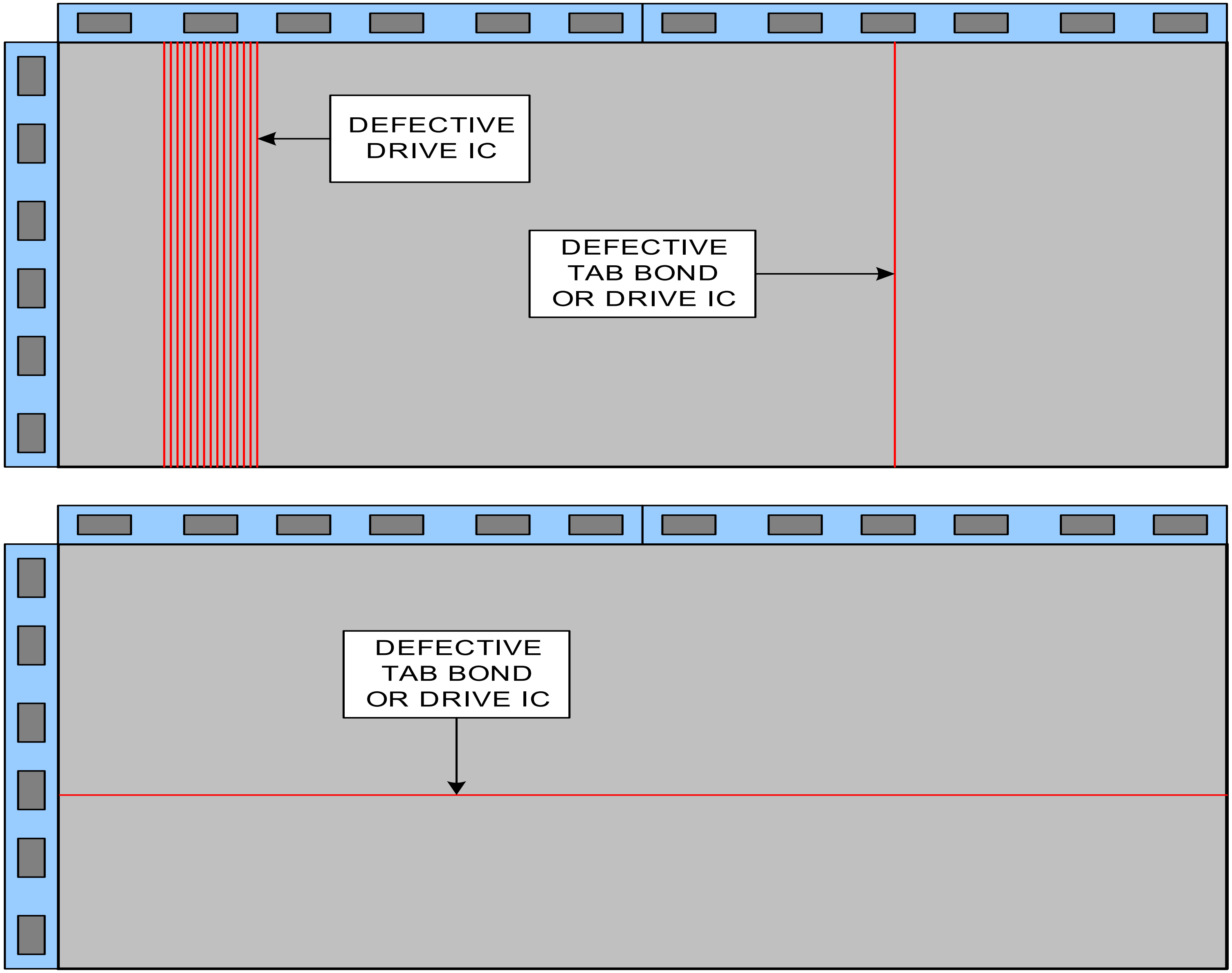


FIGURE 4-6
TYPICAL LCD PANEL FAILURES

Failures involving the LCD panel are usually displayed with the following symptoms:

- Physical damage such as cracks in the panel, a single pixel or group of pixels that always on or off, or random sections of the panel which are completely dark.
- Source driver failure. This symptom appears as a single vertical band around 1 to 2 inches (depending on the panel size) and can be black, white, or any other color. It can also contain video information with distortion. A single vertical line that is dark or colored. This may be due to a tab bonding failure from the IC to the panel but either cause requires the replacement of the panel.
- Gate driver failure. These IC's operate in a "bucket brigade" fashion. As mentioned earlier, the gates drivers scan each horizontal line starting at the top. If any one of the gate drivers fails, all of the subsequent drivers below it will fail to operate properly. This symptom is usually indicated by normal video on the upper portion of the screen followed by distorted video from the point of the failed IC and downward.
- Any horizontal lines. The gate drivers are activated by a single source of timing information so any single horizontal line or groups or random horizontal lines are caused by an output failure from a gate driver or a loss of the tab bond to the panel.

TCON Failures

Failures in the timing control circuits of the TCON can produce symptoms of absolutely no video or generate lines and patterns that usually cover all or a substantial part of the screen. Determining if the TCON is the cause of a "no video" condition is a bit more difficult since there are no indications on the screen to analyze.

Troubleshooting a "DEAD" TCON

Many of the Sony television models over the last few years will detect a TCON that has completely failed. The communications data between the video process circuits and the TCON will cease to communicate if the TCON fails completely. This will cause the television to shut down and display a diagnostics code indicating a failure of the TCON. Not all chassis designs have this feature and it is not found on older models.

The typical scenario when this failure arises is for the technician to bring a video process board to the repair location. It is usually safe to assume that the problem lies on the TCON board if the replacement video board does not remedy the problem since it is highly unlikely that a replacement board with the same failure was received.

One trick to check most TCONS for functionality is to loosen the LVDS connector at the TCON (as shown In Figure 4-3) while the unit is turned on. Handle the LVDS connector with care and be certain to fully release the lock tabs. Gently rock the cable in and out of the connector while observing the screen for any response. Depending on the chassis, the symptoms of the screen may be gentle white flashes, intermittent colored lines, or a screen full of random patterns. The idea at this point is to provoke some kind of response on the screen. TCON boards that have failed will not usually generate any type of response on the screen.

Another helpful procedure is to rapidly heat and/or cool the TCON with hot air devices or circuit coolant and watch for patterns to appear on the screen.

Figure 4-7 illustrates 2 examples of a loss of control data to the drive IC's. In the first example, an entire group of column drivers has lost the data stream for red. The second example involves the complete loss of drive data for all RGB information to the right side of the screen. This is sometimes caused by the flat cable connecting the TCON to the LCD panel coming loose. The area of missing video can be dark or completely white depending on the panel design.

Service Tip: Select an inactive input (or one that is known to be a 4:3 SD source) and toggle between the "normal" and "zoom" modes. If the lines follow the zoom changes, the problem is located on the video process board. If they stay in the same place, they are originating in the TCON or LCD panel.

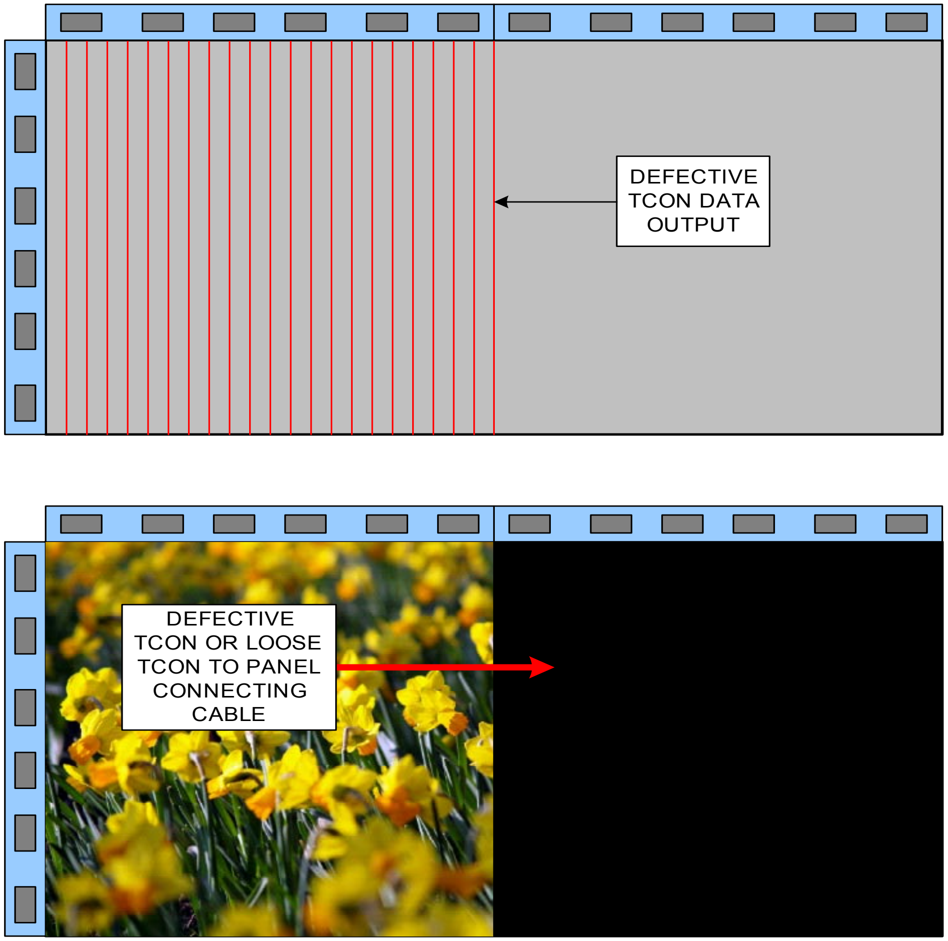
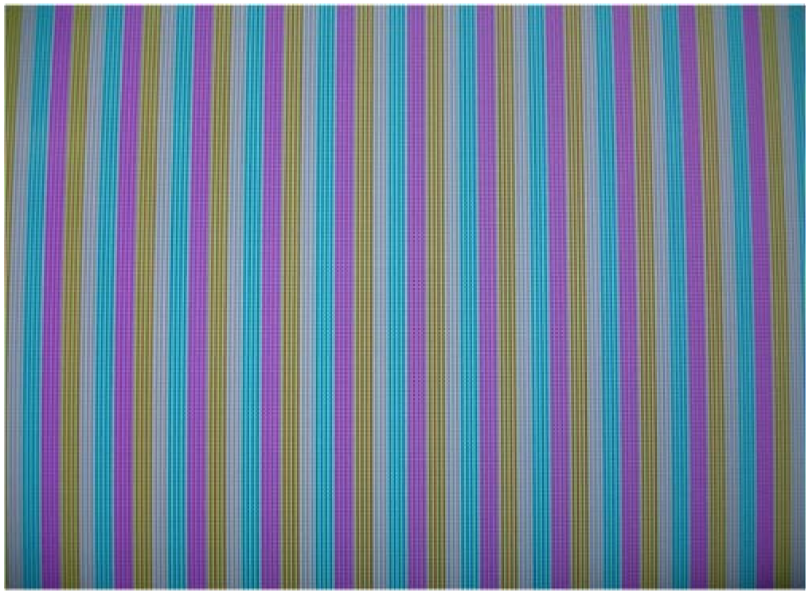


FIGURE 4-7
LCD TIMING CONTROL FAILURES

Examples of Actual TCON Failures

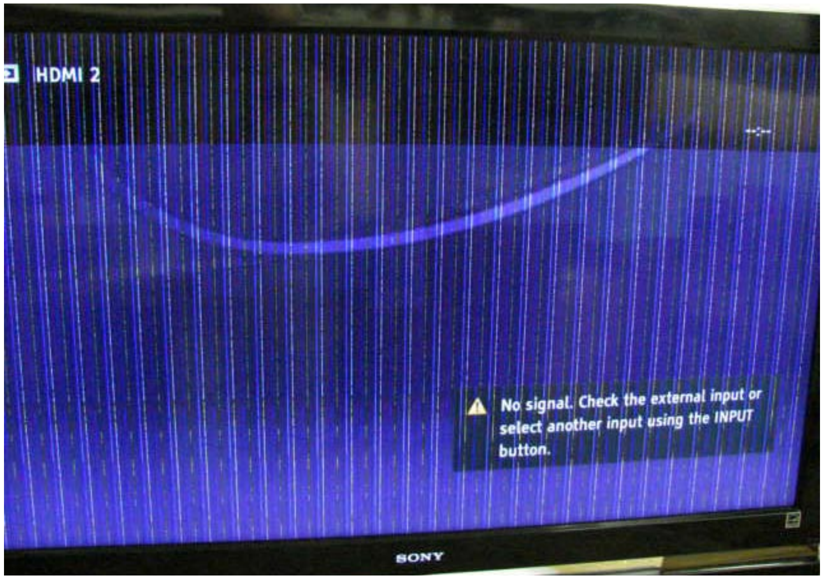
The remaining illustrations show other TCON failures that have been encountered in the field. The idea is to get a grasp of the concept of TCON induced failures to avoid unnecessary parts replacement.



REPETATIVE STAIONARY LINES

MULTIPLE SOURCE DRIVE IC FAILURE

MULTI-COLORED LINES. NOTE THE PRESENCE OF SOME ACTIVE VIDEO INDICATING THE VIDEO PROCESSOR IS NOT THE CAUSE



MULTIPLE EVENLY SPACED LINES NOT AFFECTED BY PICTURE ZOOMING

SYMETRICAL RED BOXES

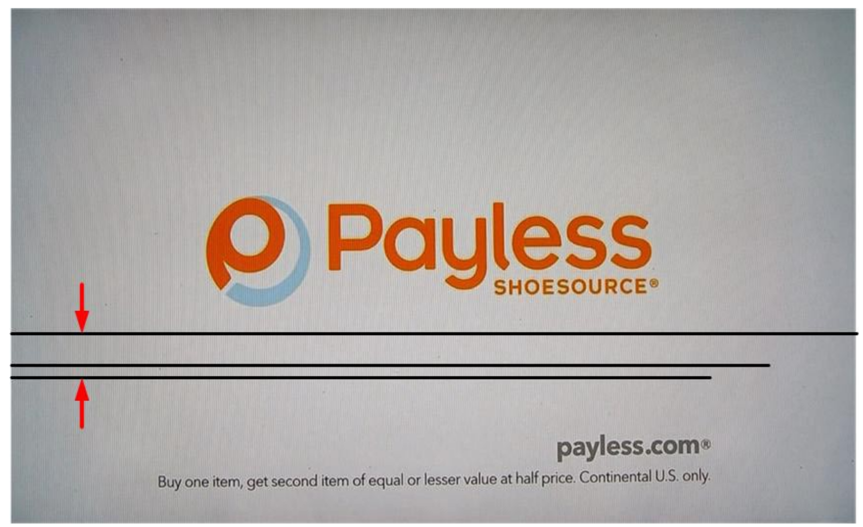
LOADED SOURCE DRIVE DATA LINE

LCD Panel Failures

Below are some photos of actual LCD panel failures. Note that most issues tend to be isolated to a certain area of the screen with the exception of failures of the source drivers. The source drivers can cause thin horizontal line issues and can also affect a large area of the screen.

SOURCE DRIVE IC FAILURE

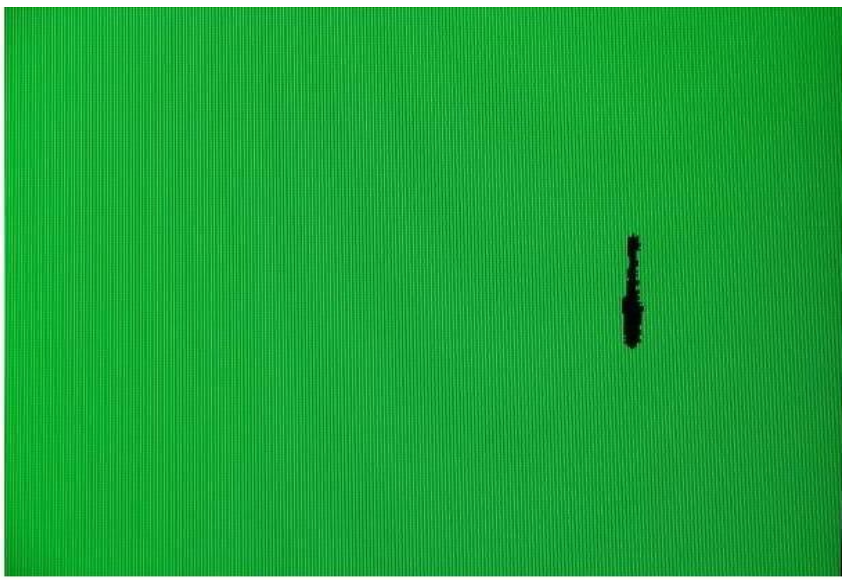
GATE DRIVER FAILURE



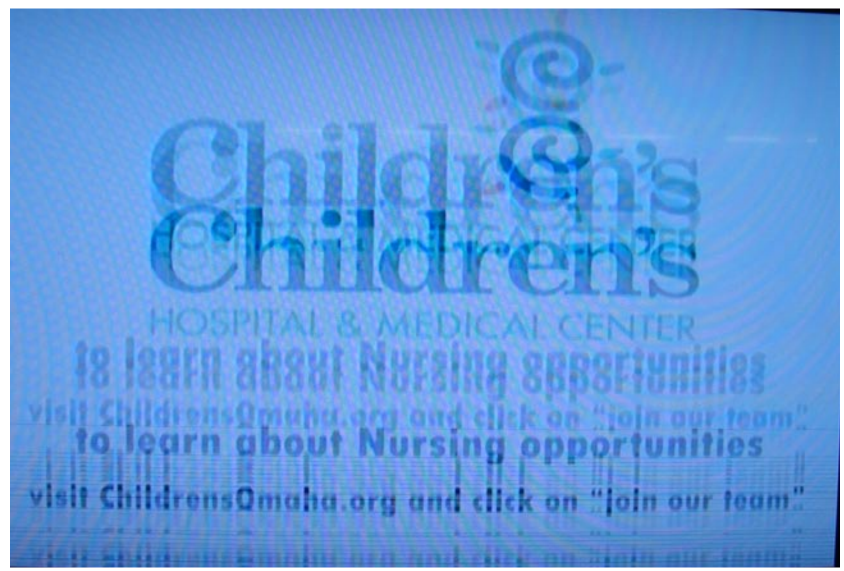
GATE TAB BOND FAILURE

SOURCE TAB BOND FAILURE

GATE TAB BOND FAILURE



MULTIPLE PIXEL FAILURE



GATE TAB BOND FAILURE

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