



LCD Quality Standards

Industry Standards for LCD Screens

The following page sets out laptop screen industry standards concerning dead pixels and provides background information regarding LCD screen technology.

Dead Pixels

LCD (liquid crystal display) screens come in various sizes and resolutions. Resolution is defined as the number of pixels or small dots that make up an LCD screen. The pixel is the smallest unit that makes up an image. Most screens sold today are TFT active matrix LCD screens. TFT active matrix is a technology in which each pixel has a transistor attached to it to control the backlight shining through. Each pixel is made up of 3 sub-pixels (red, green and blue) with each having its own transistor. Each of these pixels turns on and off and filters light through colored sub-pixels which results in an image. Occasionally, these individual transistors will short or remain open resulting in a dead pixel. There are two occurrences which define a dead pixel: a "lit" pixel, which appears as one of several randomly placed white, red, blue and/or green pixel elements on a dark background; or a "missing" pixel, which appears as a black dot on light-colored background.

Considering the number of pixels contained in an LCD panel, the defective rate should dead pixels be present is usually quite minute. For a typical laptop screen, a 14.1" screen with XGA resolution (1024 x 768 pixels), has a total of 2,359,296 red, green and blue pixels (1024 x 768 x 3). So a screen with 5 dead sub-pixels has a defective rate equal to 0.0002%.

Why has the industry established an acceptable level of dead pixels?

To better answer this question, a comparison between a TFT active matrix LCD screen and a CRT monitor will help illustrate why the market players have established standards for LCD screens.

Pixel defects can be noted in both CRT monitors and LCD screens. During the manufacturing process for both CRT monitors and LCD screens, pixel outage is difficult to assess. Only upon completed assembly can an individual display be assessed for dead pixels. The more units classified as defective in a production line due to pixel malfunction, the lower the overall yield. The lower the overall yield results in scrapped materials from those defective units and therefore higher production costs. With higher volume production and lower material costs as well as improved manufacturing methods for CRT monitors, if there is a decrease in yield it has a minimal effect. However, for LCD screens which have lower production yields and higher material costs based on current manufacturing methods, every attempt is made to reduce the number of scrapped displays. The higher production cost of LCD screens is the main reason this issue is more prominent with LCDs than it has been with CRT monitors.

As a result of higher production costs of LCD screens, like their CRT counterparts, LCD manufacturers and laptop makers have set limits as to how many defective pixels are acceptable for a given LCD panel, based on user feedback and manufacturing cost data. The goal in setting these limits is to maintain reasonable product pricing while minimizing distraction from defective pixels for maximum user comfort. LCD screen manufacturers (i.e. Hitachi, LG, Philips, Samsung and Sharp) and laptop makers (i.e. Apple, Compaq, Dell, IBM and Sony) have worked together to strike a balance between functionality of a screen and affordability of a laptop. The very price that a customer has paid for a laptop computer is directly related to the dead pixel limits set by these industry players. The cost of accepting only perfect displays could nearly double the price of a portable computer using an LCD screen. This is true of all laptop computers using LCD technology.



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What is the industry standards regarding dead pixels?

There is no one clear industry standard regarding an acceptable level of dead pixels. Each LCD screen manufacturer and each laptop maker have their own dead pixel standards. And unfortunately, in most cases the end-user is not aware of their respective laptop brand's dead pixel policy until after a laptop is purchased and dead pixels are noticed. MicroScreen, however, would rather take the approach of educating our customers about industry standards and being proactive in informing our customers about our dead pixel policy.

The following table is a summary of various laptop brands' and screen manufacturers' dead pixel policies. The data provided below is subject to change by the laptop makers and LCD manufacturers and vary depending on size, resolution and model. The amounts represent in general the number of dead pixels required for screen replacement.

| Laptop Brand / OEM | Bright Dots | Dark Dots | Total Dots |
|--------------------|-------------|-----------|------------|
| Dell | 7 | 7 | 7 |
| IBM | 5 to 11 | 5 to 16 | 9 to 16 |
| HP/Compaq | 7 | 7 | 9 |
| LG.Philips | 6 | 6 | 10 |
| Sharp | 7 | 7 | N/A |
| MicroScreen | 3 | 3 | 3 |

Conclusion

MicroScreen recognizes the importance of customer satisfaction and providing a quality product. In keeping with the industry, MicroScreen either meets or exceeds industry standards. While MicroScreen strives to provide the best dead pixel policy, we cannot exceed those standards provided to us by the manufacturers and still provide the best prices in the industry. We continuously monitor the industry's standards to improve our policy as manufacturing methods and production costs improve.