Edge10 Corporation Limited, Pixel Policy
Pixel Policy – Understanding about Defective Pixels in Liquid Crystal Displays

Visible pixel malfunction is occasionally noted in LCD Panels but why does it happen? Pixel outage is difficult to assess during the manufacturing process of LCDs. Only upon completed assembly can an individual display be assessed for defective pixels. The more units classified as defective due to pixel malfunction, the lower the overall yield. This results in scrapped materials and, therefore, higher production costs and greater environmental concerns thus every attempt is made to reduce the number of scrapped displays.

Active matrix TFT LCD panels achieve their beautiful images, in part, because of the individual transistor placed at each pixel which controls the backlight shining through a given pixel (see Figure 1). Occasionally, these individual transistors will short, or otherwise malfunction, resulting in a defective pixel. There are two phenomenon which define a defective LCD pixel: A "lit" pixel, which appears as one or several randomly-placed red, blue and/or green pixel elements on an all-black background; or a "missing" or "dead" pixel, which appears as a black dot on all-white backgrounds. The "lit" pixel phenomenon, more common than "missing / dead" pixels, results when a transistor occasionally shorts on and results in a permanently "turned-on" (red, green or blue) pixel. There are some possible corrective measures, such as "killing" a transistor using a laser, however, this just creates black dots which would appear on a white background. Fixing the transistor itself is not possible after assembly. Additionally, it is not possible to turn a "lit" pixel off, except for the aforementioned laser method, which essentially just makes the transistor in-operational, thus resulting in a black dot.

Turned on or "lit" pixels are a fairly common occurrence in LCD manufacturing. All LCD manufacturers 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. Considering the number of pixels contained in a LCD panel, this defective rate is quite minute.

For example, a 15” 4:3 panel with a native resolution of 1024x768 pixels contains a total of 2,359,296 red, green and blue pixels per panel (1024 x 768x3 = 2,359,296).

Therefore, a panel with 20 lit pixels would have a pixel defect rate of: (20/2,359,296)*100 = 0.0008%

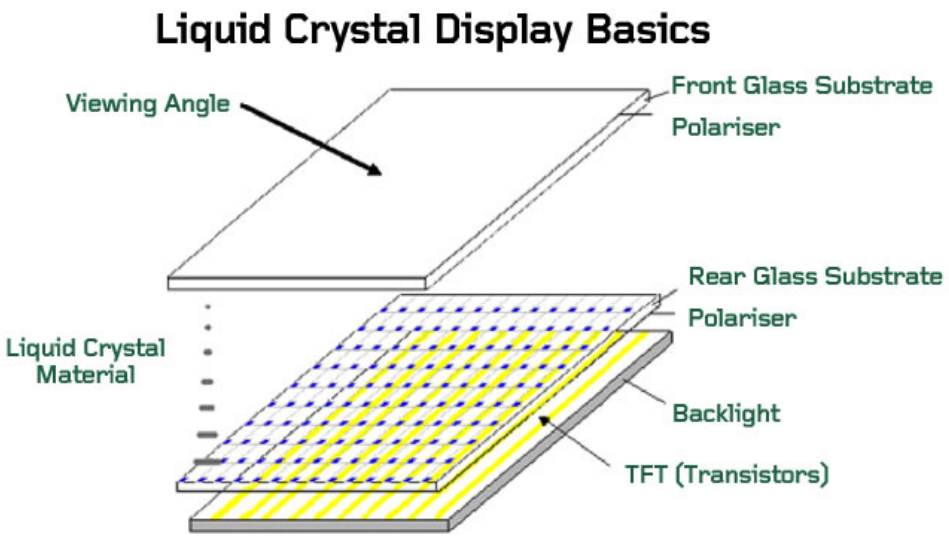


Fig. 1 : Cross Section View of A LCD Panel
Note: The rear glass substrate contains both the LCD material and each pixel's transistor.

Fortunately, the most widely-used operating system, Windows XP, and Windows based applications tend to mask, or hide, the phenomenon of turned-on pixels due to their reverse video of black characters on a white background.

Summary

Until yields increase, material costs come down, or new technology is developed to address the issue of defective pixels in LCDs, this phenomenon will occasionally present itself to some users under some circumstances. Most users, however, will never notice LCD pixel defects within the acceptable range. In addition, despite the occasional lit pixel to contend with. Typically transistors do not generally "go bad" over time, so if there are no noticeable dead or lit pixels upon initial purchase, then chances are none will become defective over time.

What defines the standard ISO 13406-2?

The standard ISO 13406-2 is a component of the TUEV ergonomics examination and defines the LCD specific ergonomics standards. One of the quality criteria of the ISO standard is the pixel error tolerance. The standard ISO 13406-2 provides transparency and gives the customer and the manufacturer a clearly defined and thus comparable warranty claim definition, in which the pixel fault classes are given. An overview of the pixel fault classes and types is shown in the following excerpt from the standard ISO 13406-2.

The table defines the maximal permissible number and kind of pixel faults per 1 million pixel.

Pixel defect category	The number of pixel defects is defined per 1 million pixel.		
	Defect Typ 1 (constantly bright pixel)	**Defect Typ 2** (constantly dark pixel)	**Defect Typ 3** (defect subpixel, either constantly bright red, green, blue) or constantly dark)
I	0	0	0
II	**2**	**2**	**5**
III	5	15	50
IV	50	150	500

Additionally to the individual types of error the number and kind of errors are defined in the Pixel cluster in the standard ISO 13406-2. A Pixel cluster is a range form made up of 5 times 5 pixels in that which errors can arise in. The following table defines the maximally permissible number and kind of the cluster faults per 1 million pixel.

Pixel defect category	The number of pixel defects in a cluster for 1 million pixel.	
	Typ 1 and Typ 2	**Typ 3**
I	0	0
II	0	2
III	0	5
IV	5	50

Which conditions must be fulfilled according to ISO 13406-2?

The following conditions must be fulfilled according to ISO 13406-2 for the correct measurement of the pixel errors:

- preheating of the monitor to be > 1 hour,
- ambient temperature 25°C +/- 5°C
- relative air humidity 40-70%
- test must be accomplished in a dark area

The pixel faults are defined in the following way:

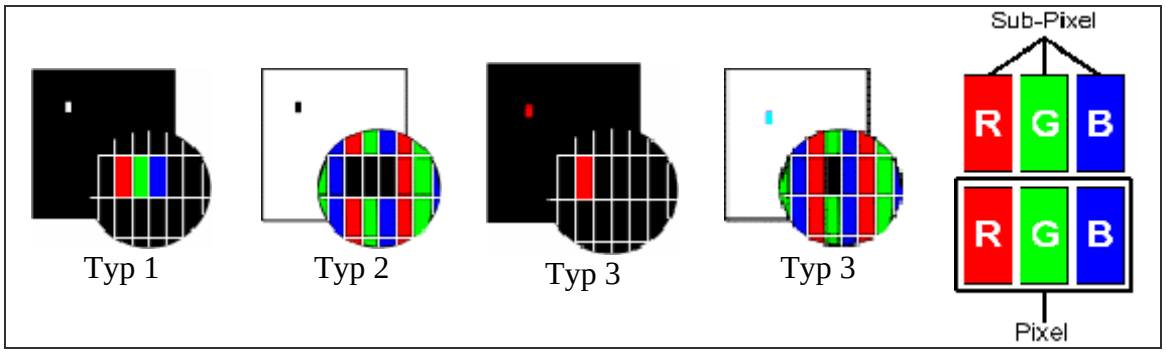
A pixel is a group of 3 assigned subpixels (red, green, blue). Each subpixel corresponds to a transistor.

Pixel fault Typ 1: constantly bright pixel

Pixel fault Typ 2: constantly dark pixel

Pixel fault Typ 3: defect subpixel, either constantly bright (red, green, blue or constantly dark)

For example:

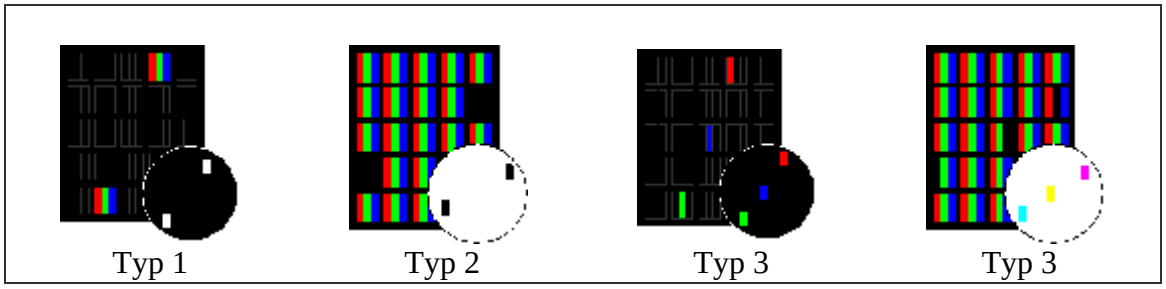


A cluster is an area of 5 x 5 pixel

Cluster pixel fault Typ 1 and Typ 2: constantly bright or dark pixels within the clusters

Cluster pixel fault Typ 3: defect subpixel, either constantly bright red, green, blue or constantly dark within the cluster.

For example:



How can you calculate the number of permissible pixel faults?

The number of permissible pixel faults can be calculated with the following formulae:

(**number of errors** = **number of pixels of the physical resolution** x **number of errors in the pixel fault category** / **1.000.000**) with rounding upward The following table defines the maximum permissible number of pixel faults for the respective resolution types validly for pixel error class II.

	Edge10 displays	**Physical Resolution**	**Amount of Pixel**	**Maximally permissible number of errors for the pixel error class II in accordance with ISO 13406-2**				
				Typ 1	**Typ 2**	**Typ 3**	**Cluster fault Typ 1 and Typ2**	**Cluster fault Typ 3**
XGA	15"	1024 x 768	768 432	2	2	4	0	2
SXGA	17-19"	1280 x 1024	1 310 720	3	3	7	0	3
SXGA+	20"	1440 x 1050	1512000	3	3	8	0	3
UXGA	20"	1600 x 1200	1 920 000	4	4	10	0	4
WXGA	19" Wide	1440 x 900	1 296 000	3	3	6	0	3
WSXGA+	20"-22" Wide	1680 x 1050	1 764 000	4	4	9	0	4
WUXGA	24" Wide	1920 x 1200	2 304 000	5	5	12	0	5

So, you can have a 19" Wide LCD monitor with 3 bright pixels and it would not be classed as faulty, however with 3 or more bright pixels this would be classed as faulty.

More details can be found about ISO13406-II from the International Standards Organisation Website.