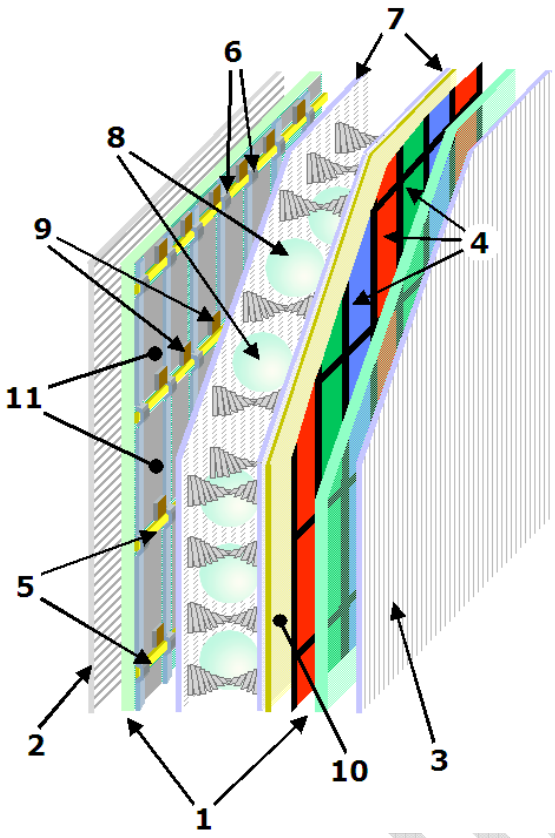
Display Defects

1. Introduction

This information sheet gives more information on how to recognize display defects and determine whether a display conforms to quality standards.

A TFT LCD monitor consists of multiple layers (see figure below).



1 glass substrates
2 horizontal polarizer
3 vertical polarizer
4 RGB colour mask
5 horizontal control wires
6 vertical control wires
7 polymer layers
8 spacers
9 Thin Film Transistors (TFT)
10 front electrode
11 rear electrode

Display defects can be caused by contamination that entered between layers either during production or during use, short-circuits between control wires that either keep a pixel or one colour of a pixel dark or bright, faulty control wires that keep a whole line of pixels turned on or off, scratches on polarizer or glass substrate caused by mistreatment, dents …

A monitor contains millions of pixels (e.g. **MONSCA6**: 1280x1040=1,331,200), making it technical nearly impossible to produce a display without pixel defects. Therefore certain standards were created describing the number, size, location… of above mentioned defects that are acceptable (allowed) in a TFT LCD display. For some industries (e.g. aviation) these standards are much more stringent than for others.

2. Definitions

Bright dot defect
Pixels or sub-pixels that appear bright and are visible through a 5% ND (Neutral Density) filter when a black pattern is displayed. Note that the ND filter must be held parallel to the surface at a distance of 2.5 to 3 cm.

BM (black matrix) defect
White points on a display that is switched off.

Dark/bright spot
Points on the display that appear dark or bright, usually due to contaminations. These spots do not change in size or intensity when adjusting the contrast.

Dark/bright lines
Lines on the display that appear dark or bright, usually due to contaminations.

Dark dot defect
Pixels or sub-pixels that appear dark when an RGB coloured pattern is displayed.

Line defect
A complete line of pixels, horizontally, vertically or diagonally, that appear bright or dark.

Mura
Brightness of the display is not uniform over the whole display area.

Pixel
Smallest addressable screen element. For colour TFT displays, these are made up of 3 separate colour elements: red, green and blue. Varying the intensity of these 3 colours (or dots) can create pixels of any desired colour.

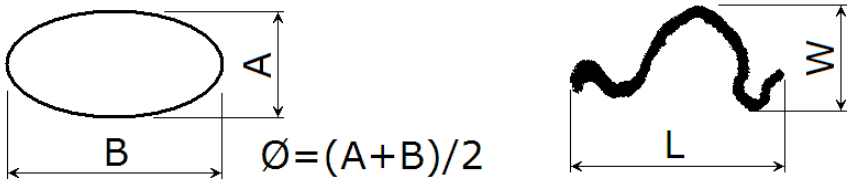
Polarizer dent
White spots on the display that become visible on a darker background. Their size remains the same when adjusting the display settings.

Polarizer scratch
Lines on the display that are visible against a darker background. These lines always have the same length.

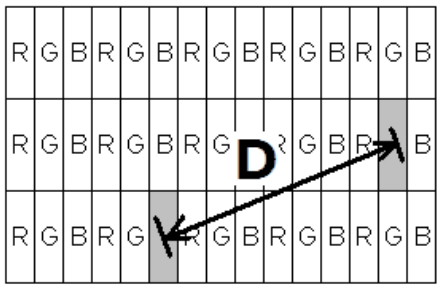
Sub-pixel (dot)
One colour element of a pixel.

3. Defects

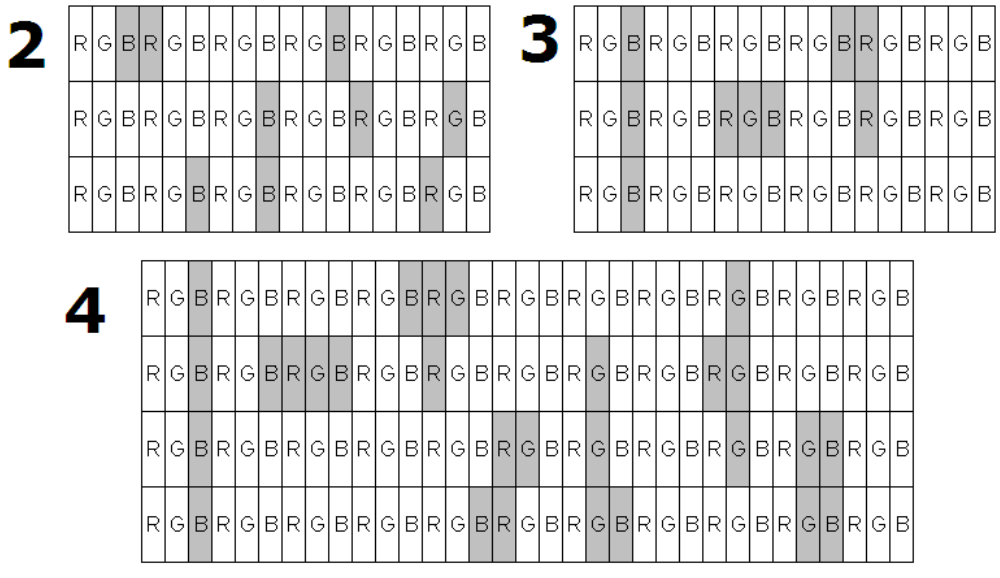
A defect can be shaped either round or elongated.
A round defect is defined by its average diameter, which equals the sum of max. height and maximum width divided by 2.
An elongated defect is defined by its length and width.



The distance **D** between two defective dots is measured as indicated below:



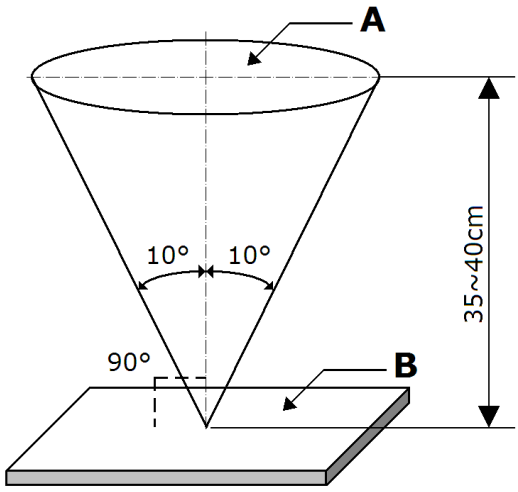
Adjacent dots are defined as follows (examples):



4. Procedure

Inspection conditions

- Viewing distance is approximately 35 ~ 40 cm (for inspecting adjacent dots and distance between defect dots, this distance is much closer)
- Viewing angle is normal to the LCD panel (max. 10° deviation)
- Ambient temperature is 25 ± 5°C
- Ambient humidity is 60 ± 5% RH
- Ambient illuminance is between 300 ~ 500 Lux.
- Input signal timing should be typical value.



A	eye position
B	LCD panel

Inspection criteria

Refer to the definitions in **§2**.

N = number of defects.

defect type			**limit**	
visual defect	scratch		0.03mm ≤ W ≤ 0.1mm L ≤ 10mm	N ≤ 4
	defect	round	0.3mm ≤ Ø ≤ 1.0mm	N ≤ 5
		linear	W ≤ 1.0mm L ≤ 3.0mm	N ≤ 5
		polarizer	0.3mm ≤ Ø ≤ 1.0mm	N ≤ 5
		total allowed	N ≤ 10	
electrical defect	single dot	bright*	N ≤ 6	
		dark	N ≤ 6	
		total allowed	N ≤ 9	
	adjacent dots	2**	≤ 3 pairs	
		3**	≤ 2 sets	
		4**	≤ 1 sets	
	distance between 2 bright dots		≥ 10mm	
	line defects		N = 0 (not allowed!)	

***:** visible through a 5% ND (Neutral Density) filter

****:** adjacent dots also add to the single dot counter

Note: other defects that may occur e.g. mura are subject to user interpretation and should be evaluated individually.