LCD screen quality specifications for Apple products.

This document discusses Apple's warranty policy regarding defective pixels on color displays for the **Macintosh PowerBook 1400C/CS, 3400C** and the **Twentieth Anniversary Macintosh**.

It has become necessary because of the present limits of the technology and the requirement from our customers for quality products, especially in the high end range.

The document is produced to clarify the situation and to avoid unnecessary screen replacements.

Note: service modules, exactly like new products, follow those specs, and replacing a LCD that is within the specifications outlined in this document, will not guarantee that the replacement will be better than the original one.

Background Info

Each pixel on an active matrix color display consists of 3 sub-pixels (red, green and blue). Each sub-pixel has a transistor which controls light transmission.
For the Powerbook 1400 and 3400 there are 1.5 million transistors per display (800x600 x 3).

Due to the present limits of the technology, process constraints, costs, and manufacturing yields, numerous sub-pixel or pixel anomalies are allowed (red, green, blue, black, white) by all manufacturers, and Apple specifications of the cosmetic standards required to pass judgment on the Flat Panel Displays used in our range of portable computers are among the best in the industry.

Test environment

To establish if a LCD display should be replaced under warranty or not (in other words to establish if it is within specifications or not), the displays should be inspected as follows:

> Lighting to be fluorescent (daylight type) 900 - 1000 Lux.
> Backlight set to maximum brightness
> Unit to be powered up for at least 1 minute.
> A magnifying lens is necessary for sub-pixel analysis.
> To display the Red, Green, Blue, **Black** and White screens should be used the "Display Service utility" 4.1 or later, that can be found on the Service Source Companion CD in the "diagnostic" folder. Choose the option "Powerbook color".

The parameters to be used are:

-number of defective pixel or sub-pixel
-position of those pixel/sub-pixel
-distance between damaged pixel/sub-pixel
-dimension of the anomaly

The following tables contain:

- description of the most common defects (**Anomaly**),
-the type of test screen to be used to verify it (**Test Screen**),
-what to look for (**Criteria**),
-max. number of defects accepted (**Accepted**),
-and minimum number of defects for a warranty replacement (**Reject**).

1   Active Matrix 12.1" for

Powebook 3400
Twentieth Anniversary Macintosh

Distance from the inspector's eye to the display should be at least 30 cm

It is divided into two categories: defects at sub-pixel level, and defects at pixel or larger level.
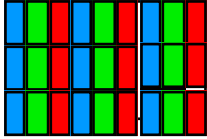
1* At sub pixel level

Anomaly	**Test Screen**	**Criteria**	**Accept**	**Reject**

1.1• Missing dots within a pixel :

Anomaly	**Test Screen**	**Criteria**	**Accept**	**Reject**
-missing red subpixels	on Red screen	1 Sub-pixel	9	10
-missing green subpixels	on Green screen	1 Sub-pixel	9	10
-missing blue subpixels	on Blue screen	1 Sub-pixel	9	10
-Blue dots	on Black screen	1 Sub-pixel	9	10
-or Green dots	on Black screen	1 Sub-pixel	9	10
-or Red Dots	on Black screen	1 Sub-pixel	9	10

1.2 Missing dots in adjacent pixels : (NOTE See Appendix 1 for definition of "adjacent dots")

Anomaly	**Test Screen**	**Criteria**	**Accept**	**Reject**
-Missing adjacent dots	on white screen	2 Sub-pixels in close proximity	5	6
-Missing adjacent dots	on white screen	3 Sub-pixels or more in close proximity	0	1

2* At pixel level

Anomaly	Test Screen	Criteria	Accept	Reject
-Black Spot	on White screen	diameter <0,5mm	4	5
-Black spot	on White screen	diameter >0,5mm	0	1

2   Active Matrix 11.3" for Powebook 1400

Distance from the inspector's eye to the display should be at least 50 cm

It is divided into two categories: defects at sub-pixel level, and defects at pixel or larger level.

1* At sub pixel level

Anomaly	Test Screen	Criteria	Accept	Reject

1.1• Missing dots within a pixel (a pair of sub-pixels count as 1 anomaly):

Anomaly	Test Screen	Criteria	Accept	Reject
-missing red subpixels	on Red screen	1 Sub-pixel	10	11
-missing blue subpixels	on Blue screen	1 Sub-pixel	10	11
-missing green subpixels	on Green screen	1 Sub-pixel min distance 5 mm	10	11
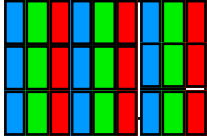
1.2• Colored dots within a pixel (a pair of sub-pixels count as 1 anomaly); minimum distance is 3 color anomalies within 10 mm

Anomaly	Test Screen	Criteria	Accept	Reject
-Blue dots	on Black screen	1 Sub-pixel	12	13
-or Red Dots	on Black screen	1 Sub-pixel	12	13
-or Green dots	on Black screen	1 Sub-pixel	4	5

1.3 Missing dots in adjacent pixels : (NOTE See Appendix 1 for definition of "adjacent dots")

Anomaly	Test Screen	Criteria	Accept	Reject
-Missing adjacent dots	on white screen	3 Sub-pixels or more in close proximity	0	1

2* At pixel level

Anomaly	Test Screen	Criteria	Accept	Reject
-Black Spot	on White screen	diameter <0,5mm	4	5
-Black spot	on White screen	diameter >0,5mm	0	1

3   Color FSTN (passive) 11.3" for Powebook 1400

Distance from the inspector's eye to the display should be at least 50 cm.
For FSTN type displays set the contrast to an optimum, and then do not adjust it again
For passive matrix displays, the criteria are different, as also the possible defects are different.

* Type II defects: the size changes by changing the Contrast Setting

Anomaly	Test Screen	Criteria	Accept	Reject
-Black spot	on White screen	diameter >0,95mm	0	1
-white spot	on **black screen**	diameter >0,95mm	0	1

also called <u>gray spots</u>, because of the gray color

* Type I defects: the size doesn't change by changing the Contrast Setting

Anomaly		Criteria	Accept	Reject
Black, white, red,	\			
	>	diameter >0,15mm	8	9
green, blue	/			

* Centerline Gap: On white screen, horizontal black line in the middle, for the full length of the screen.

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Accept	if line width < 0.05 mm
Reject	if line width > 0.05 mm

Appendix 1: Adjacent Dots definition

Adjacent dots are defective subpixels within adjacent pixels: As each pixel contains three sub-pixels (Blue, Green and Red sub-pixels), any missing sub-pixel in a pixel will remove one of the primary colors that compose the pixel.

What is acceptable => Two adjacent missing subpixels defects on adjacent pixels
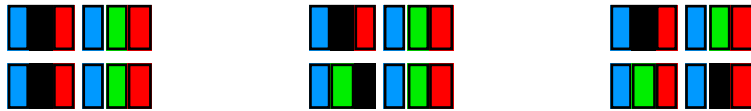
What is not acceptable => Three adjacent missing sub-pixels defects on adjacent pixels