Test and evaluation method of display screen locked integrated black

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Contents

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1 Scope

This document specifies the testing and evaluation method for display screen locked integrated black.
This document is applicable to small and medium-sized display devices (generally referring to 0.5 inch to 50 inches), as well as display terminal products that use such devices, such as smartphones, smart wearables, tablets, Notebooks, vehicle-mounted, etc., when selecting display device. It can be used as a reference for commercial display and television.

2 Normative References

This document does not have normative references.

3 Terms and Definitions

The following terms and definitions apply to this document.

3.1 Locked screen

The state of the display screen when it is not powered on.

3.2 Integrated black

The degree of the color difference between the display area and the ink area, as well as the color difference when observing the screen from various azimuth angles under a large viewing angle, when the screen is locked. Also known as grayscale color difference.

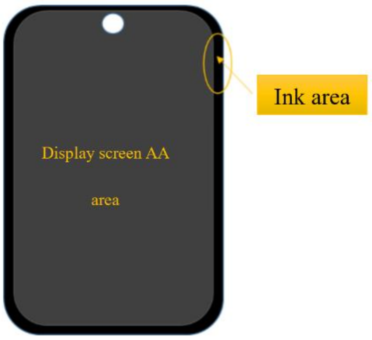


Figure 1 Schematic diagram of the display area (AA area) and ink area on the display screen

3.3 Lightness

The ratio of the perceived visual lightness of the color stimulus observed by the observer to the visual lightness of the fully diffuse reflective volume under the same lighting conditions, which is represented by L. It is the coordinates of the color lightness of an object in the CIE 1976 uniform color space.

3.4 Hue

The characteristic of distinguishing colors from each other at different wavelengths.
Note: The three-color sensitive cone cells of the human eye experience different color sensations after being stimulated by different wavelengths, and hue can be used to indicate the different color psychological reactions caused by light stimulation of different wavelengths.

3.5 Chromatic aberration

The difference in color perception between two colors using numerical methods to represent.

Note: If two color samples are calibrated with colors L *, a *and b *, the total color difference △E between the two samples is called the "color difference unit" in absolute units of 1. One color difference unit is approximately 5 times the visual color difference recognition threshold.

4 Abbreviations

For the purpose of this document, the abbreviations below apply.

AA area	Active Area
SCI	Specular Component Include
SCE	Specular Component Exclude

5 Testing conditions

5.1 Environment condition

Measure under the following standard conditions:

——Temperature: 23 ℃~27 ℃;

——Relative humidity: 25%~85%;

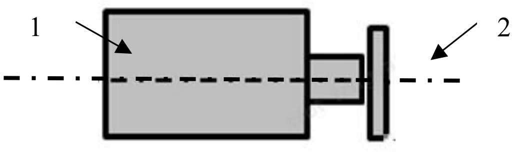
——Atmospheric pressure: 86kPa~106kPa.

5.2 Testing equipment

5.2.1 Spectrophotometer

The spectrophotometer's light source is a point light source, and when testing the reflection color, it should meet the geometric conditions of di: 8 ° (SCI, including mirror components) and de: 8 ° (SCE, excluding mirror components) for measurement; The spectrophotometer should meet the geometric conditions of di: 0 ° (SCI, including regular components) and de: 0 ° (SCE, excluding regular components) when testing the transmission color.

The schematic diagram of the testing system composed of the testing instrument and the tested display device is shown in Figure 2.



In the picture:

1- Testing instruments

2- Device under test

Figure 2 Schematic diagram of the testing system composed of a spectrophotometer and the device under test

5.2.2 Multi angle colorimeter

The Multi angle colorimeter's light source is a point light source, which should be able to measure L, a, and b from at least 5 observation containing at least from 5 observation angles when illuminated by an incident light source at around 45 °. The schematic diagram of the testing system composed of the testing instrument and the tested display device is shown in Figure 3. The light source is incident from a 45 ° position onto the tested display device, and detector receives reflected light form at least 5 directions. The results of L, a, and b are directly calculated through the internal program of the instrument. During the testing process, it is necessary to ensure that the pressure point at the bottom of the multi angle colorimeter is in complete contact with the tested display device, in order to avoid the influence of external light.

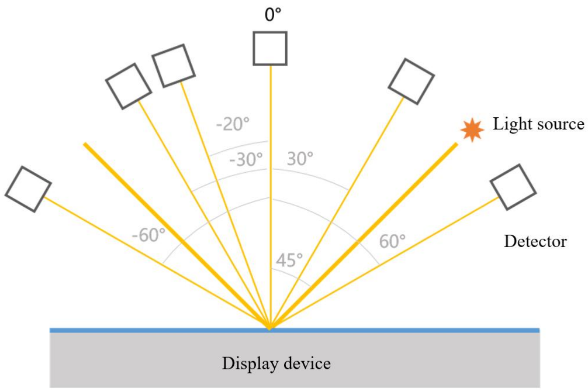


Figure 3 Schematic diagram of the testing principle of a multi angle colorimeter

5.3 Testing Settings

5.3.1 Stability time

To ensure that the characteristics of the tested sample do not show significant changes over time after the measurement begins, the tested sample should be kept in standard working condition for 10 minutes to ensure stable performance.

5.3.2 Sample placement

5.3.2.1 Spectrophotometer

According to the size of the testing area, install corresponding aperture target covers (with diameters of 3mm, 4mm, 8mm, and 25.4mm respectively); According to the testing requirements, set the "observation angle and light source" and "list options" respectively; Follow the software instruction to perform zero calibration. First, use a black zero calibration box for 0% calibration, and then use a white calibration board for 100% calibration.

5.3.2.2 Multi angle colorimeter

Choose the appropriate standard light source according to the actual situation, the light source is usually the artificial light source D65 which is a point light source that simulates standard sunlight, with a color temperature of 6500K. The size of the testing area is 23 mm or 12 mm in diameter; For specific calibration methods, please refer to the instrument operation manual. It is recommended to perform an instrument inspection with the blue standard version every 30 days. The instrument must be calibrated with a blackboard and whiteboard every three months. In order to ensure the accuracy of the testing azimuth angle between the multi angle colorimeter and the display device, an additional angle testing device with a 360 degree (angle error <0.1 degrees) should be installed. The multi angle colorimeter should be fixed on the upper part of the device, and the display device should be fixed on the lower part of the device to ensure that the pressure point of the multi angle colorimeter can fully and uniformly contact the surface of the display device, Multi angle testing can be achieved by rotating the lower part of the device.

6 Testing and calculation methods

6.1 Positive angle testing and calculation methods

6.1.1 Testing methods

The testing steps are as follows:
1) According to the size of the testing area, install the corresponding aperture target cover on the spectrophotometer. Observation angle and light source setting: Select a 10 ° observation angle for the vehicle-mounted sample, and the other samples will depend on the actual situation. The default test light source is D65; A zero calibration is needed Before actual testing.
2) When testing the reflectivity of the AA area of a display device, the center of the AA area of the screen should be placed directly facing the target cover of the testing instrument. The "facing" refers to the direction in which the human eye observes text and images under normal circumstances when the screen is turned on. The test results obtained are the lightness L, reflectivity R, and hue a and b under the conditions of SCI with specular reflection light and SCE without specular reflection light. The lightness L, reflectivity R, and hue a and b under SCI conditions are selected as the final results.
3) It is not conducive to testing, because ink area of ordinary OLED display devices is the small. Therefore, the reflectivity and hue of the ink area of general display devices can be tested through, the standard display cover with ink at the bottom (size 3cm * 3cm and above) can be tested. Similarly, the lightness L, reflectivity R, and hue a and b under SCI conditions can be selected as the final results.
4) At least 5 repeated tests should perform on each sample, and select the average value as the final result.

6.1.2 Calculation method

To determine the integrity of the tested display device, ΔE_1 is used to describe the difference in reflection lightness L and hue a and b between the AA area and the ink area under a positive perspective. The calculation formula is:

$$\Delta E_1 = \sqrt{(L_{AA} - L_{INK})^2 + (a_{AA} - a_{INK})^2 + (b_{AA} - b_{INK})^2} \qquad (1)$$

In formula (1):
L_{AA} - lightness of AA area;
A_{AA} and b_{AA} - the color scheme of the AA area;
L_{INK} - Ink area lightness;
A_{INK} and b_{INK} - Ink area color scheme.

6.2 Multi angle color difference testing and calculation methods

6.2.1 Testing methods

The testing steps are as follows:
1) Adjust the equipment appropriately according to the size of the testing area to ensure that the pressure point at the bottom of the multi angle colorimeter remains stable.
2) According to the schematic diagram of the working principle of the multi angle colorimeter, the test output of the instrument is the values received by the six directional detectors in Figure 3. At the same time, for different placement positions of the tested display device, as shown in Figure 4, the values received by the six directional detectors in the previous text include the L, a, and b of different observation angles.

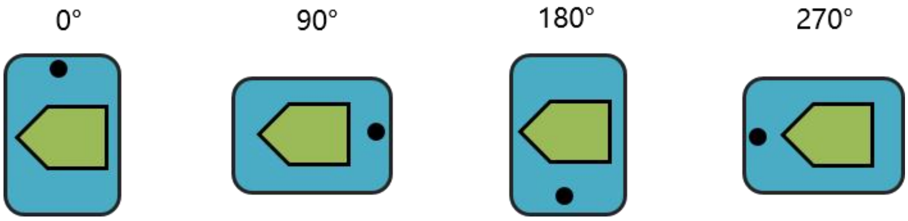


Figure 4 Schematic diagram of testing angles for multi angle colorimeter in different directions

3) The measurement method is shown in Figure 4. The multi angle colorimeter (green module) is horizontally fixed on the angle testing device, and the display device is vertically fixed under the angle testing device. The light emitted by the internal light source of the multi angle colorimeter is incident from the left end of the green module and reflected off from the right end to be received by detectors at various angles. Measure the color (L, a, b) under different viewing angles (-20 °, ± 30 °, 45 °, ± 60 °) at 0 °.

4) According to the black point in Figure 4, calibrate the orientation, rotate the display screen or multi angle colorimeter clockwise every 90 °, repeat the testing method of 3), and measure the color (L, a, b) at 90 °, 180 °, and 270 °, respectively.

5) At least 5 repeated tests should perform on each sample, and select the average value as the final result.

6.2.2 Calculation method

Calculate the anisotropic color difference in different orientations ΔE_2, The calculation formula for ΔE_2 is:

$$\Delta E_2 = \sqrt{\left(\frac{L_0+L_{180}}{2} - \frac{L_{90}+L_{270}}{2}\right)^2 + \left(\frac{a_0+a_{180}}{2} - \frac{a_{90}+a_{270}}{2}\right)^2 + \left(\frac{b_0+b_{180}}{2} - \frac{b_{90}+b_{270}}{2}\right)^2} \quad \text{.............................} \ (2)$$

In formula (2):

The subscripts of L, a and b - different testing angles of a multi angle colorimeter.

By using the above formula to calculate the values of L, a, and b at 0 °/180 °, 90 °/270 °, the anisotropic consistency of the display device at different observation angles can be obtained ΔE_2. If necessary, take the average value after testing the relative angle value.

7 Evaluation method reference

The unit color difference and the degree of perceived color difference by humans are shown in Table 1.

Table 1 The Relation between △E Color Difference and Human's Feeling degree

△E color difference (one color difference unit)	**Perceived degree of color difference**	**Integrated black degree**	**Visual perception**
0.00~0.50	Minor color difference	Excellent	Extremely faint feeling
0.50-1.51	Small color difference	preferably	Mild Feeling
1.52-3.00	Relatively small color difference	commonly	Obvious feeling
3.00-6.00	Relatively large color difference	Poor	Very obvious feeling
Above 6.00	Larger color difference	Very poor	Strong feeling