HiSilicon IP Camera Image Quality Test Standards

Issue **00B02**

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About This Document

Overview

- This document defines test standards for the image quality of HiSilicon IP cameras by specifying detailed test methods and test standards of each test item.
  - The standards provide technical guidance for the image quality verification of HiSilicon IP cameras.
  - The standards also describe test requirements of HiSilicon for the image quality of IP cameras, providing a reference for internal decision-making in HiSilicon. Such standards are applicable to the IP camera module in terms of specification formulation, product design, and quality control.
- According to test types, test items related to the image quality of IP cameras as described in this document can be divided into three test categories:
  - Specifications
  - Scenarios
  - Outdoor scenarios
- Test equipment and software that are required by the preceding test items include:
  - Hardware equipment: test light box with multiple light sources, such as D65, TL84, and F; color temperature and illuminance meter; uniform light source with adjustable brightness; various charts, including the Color Checker (24-patch) Chart, ISO12233 Chart (1x, 2x, and 4x), Kodak Gray Scale Chart Q14, and FOV Chart.
  - Software: Imatest, IPOP, Elecard, HYRes, Paint, and others
  - Other tools: triangular support, ruler, spotlight, and others

Related Versions

The following table lists the product versions related to this document.

Product Name	Version
Hi3516A	V100
Hi3516D	V100
Hi3518E	V200
Hi3518E	V201
Hi3516C	V200

Product Name	Version
Hi3519	V100
Hi3519	V101
Hi3516C	V300
Hi3516E	V100
Hi3516A	V200
Hi3559A	V100
Hi3559C	V100
Hi3519A	V100
Hi3516C	V500
Hi3516D	V300
Hi3516A	V300
Hi3516E	V200
Hi3516E	V300
Hi3518E	V300

Intended Audience

This document is intended for:

- Technical support engineers
- Software development engineers

Reference Standards and Documents

- *Technical Requirements and Test Methods for Visual Transmission Characteristics of Mobile Terminal*, Chinese national standards released on October 1, 2007
- *Technical Requirements for Imaging Performance of Camera Phones* released by National Quality Supervision and Testing Center for Cameras in 2006
- *Mobile Imaging Evaluation Process and Standards V1.1* released by OmniVision Technologies Inc. on December 22, 2008
- Test standards for the image quality of IP camera modules, which are formulated by IP camera module manufacturing enterprises, such as BYD and Foxconn
- Test standards for the image quality of terminals, which are formulated by competitors, such as Texas Instruments and Ambarella
- *HD TV and Video Camera Measurement Methods for Security Video Surveillance 110329 (CJ)*

Acronyms and Abbreviations

The following table lists the acronyms and abbreviations used in this document as well as their full names.

Acronym or Abbreviation	Full Name
AWB	automatic white balance
FOV	field of view
WDR	wide dynamic range

Change History

Changes between document issues are cumulative. The latest document issue contains all changes made in previous issues.

Issue 00B02 (2019-05-15)

This issue is the second draft release, which incorporates the following changes:

Sections 1.1.4, 1.2.4, 1.2.6, 1.2.7, 1.3.7, 1.5.4, and 1.5.7 are modified.

Sections 1.5, 1.6, 1.7, and 1.8 are deleted.

Chapter 4 is added.

Section 5.1 is deleted.

In section 5.2, Table 5-2 is modified.

Issue 00B01 (2016-05-20)

This issue is the first draft release.

Contents

Figures

Tables

1 Specifications

1.1 Resolution

1.1.1 Test Purpose

To verify the resolution of an IP camera and an analog camera.

1.1.2 Test Equipment

- IP camera:
  - Light box
  - ISO12233 Chart (1x, 2x, and 4x)
  - Color temperature and illuminance meter with the precision of 1 K and 0.01 lux
- Analog camera:
  - Light source for transmittance tests, such as a transmittance light box produced by Image Quality Labs
  - Resolution transmittance test card for analog cameras
  - Color temperature and illuminance meter with the precision of 1 K and 0.01 lux
  - Specialized A-frame with three-dimensional pan-tilt-zoom (PTZ) control

1.1.3 Test Software

- IP Camera: Imatest
- Analog camera: ResolutionCharRead, which is the self-developed software based on OpenCV

1.1.4 Test Environment

- IP camera:
  - D65 light source is available with the illumination in the range of 600 lux ± 100 lux. Ensure that ISO100 is used.
  - The difference of brightness values on the surface of the ISO12233 Chart is smaller than 20%.
  - Based on the maximum resolution of all products to be tested, the effective pixel of the lens used for verification shall be no lower than this maximum resolution.

- Analog camera:
  - The light source produced by Image Quality Labs for transmittance tests is available with the illumination in the range of 80 lux ± 10 lux.
  - Based on the maximum resolution of all products to be tested, the effective pixel of the lens used for verification shall be no lower than this maximum resolution.

1.1.5 Test Procedure

IP Camera

Step 1 Adjust the drive parameters of the IP camera to optimal settings, which are usually default settings. Set other parameters of the IP camera to normal settings, for example, set the exposure setting to the automatic mode.

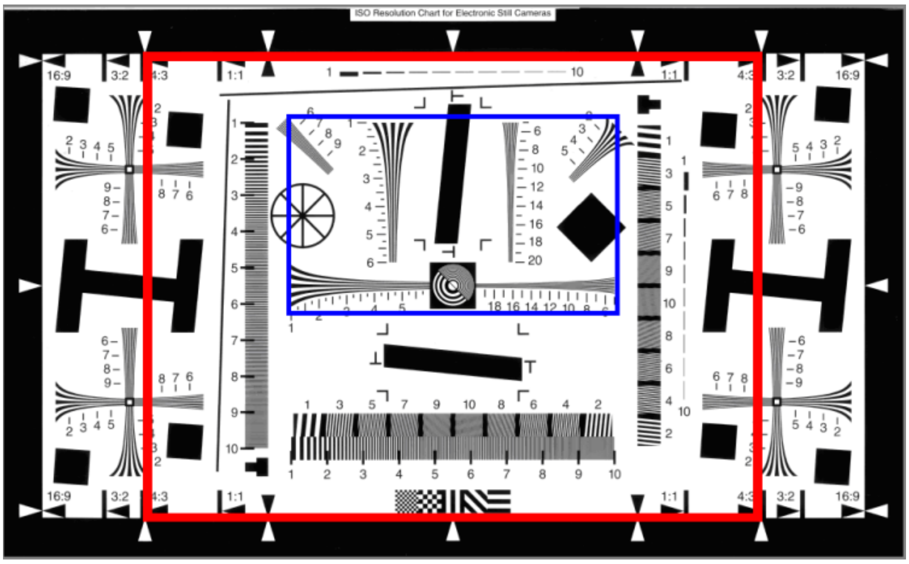
Step 2 Adjust the light source in the light box following the verification environment requirements and place the ISO12233 Chart in the light box.

NOTE

As specified in this document, the ISO12233 Chart 1x is applicable to 1.3-megapixel and 2-megapixel IP cameras, and the ISO12233 Chart 4x is applicable to IP cameras greater than 3 megapixels.

Step 3 Test the center resolution as follows: Place the ISO12233 Chart in the light box. Adjust the position of the IP camera to ensure that its optic axis is perpendicular to the surface of the ISO12233 Chart. Also, ensure that the 16:9 or 4:3 area (based on the length-width ratio of the IP camera resolution) of the ISO12233 Chart falls within the preview image of the IP camera, as shown in the red box in Figure 1-1. The following uses the IP camera resolution of 4:3 as an example.

Figure 1-1 Preview image with the 4:3 area of the ISO12233 Chart



NOTE

Focus the camera manually for three times, and capture three pictures or take a 1-min video each time for further analysis.

Step 4 Fix the IP camera and take pictures when the preview image is stable.

Step 5 Analyze the image in the blue box to get the resolution value, which is the center resolution.

Step 6 Test the corner resolution as follows: Follow the same methods in steps 3 through 5, but remember to adjust the preview area of the IP camera to test the resolution in different corners. Figure 1-2 and Figure 1-3 show the photographed areas.

Figure 1-2 Preview image in the left corner with the 4:3 area of the ISO12233 Chart

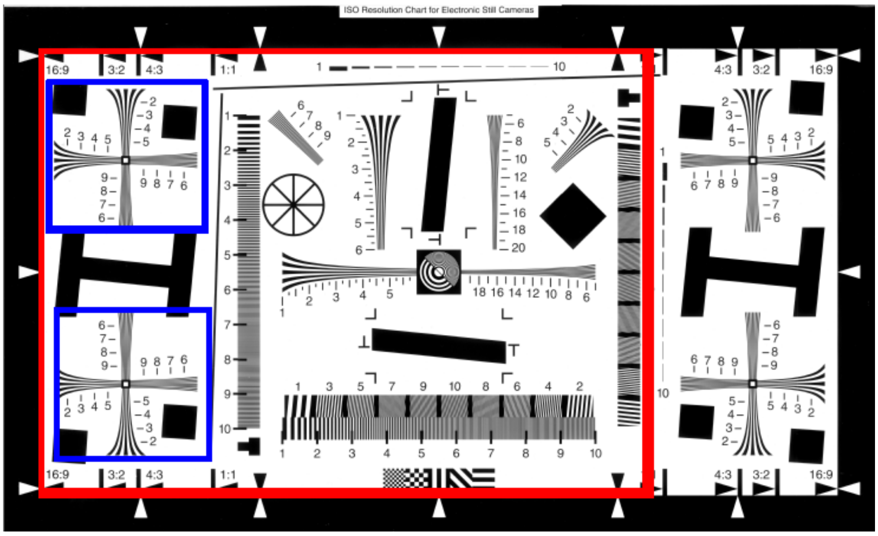
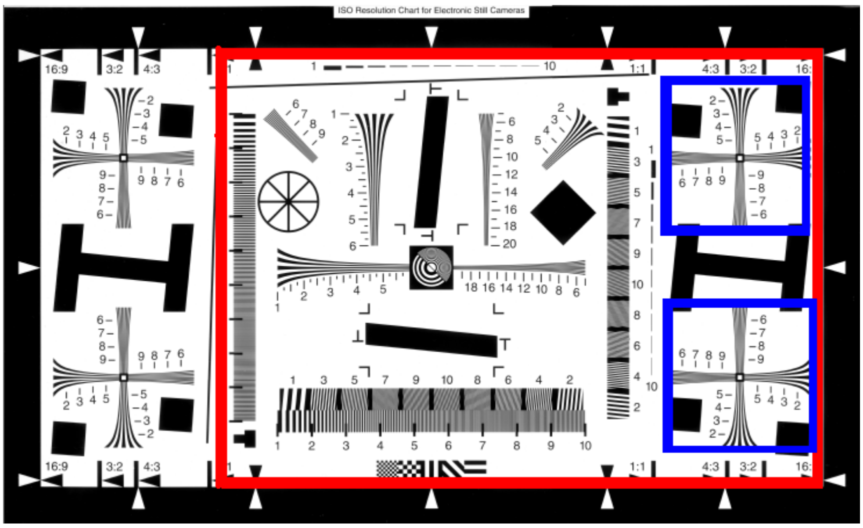


Figure 1-3 Preview image in the right corner with the 4:3 area of the ISO12233 Chart



----End

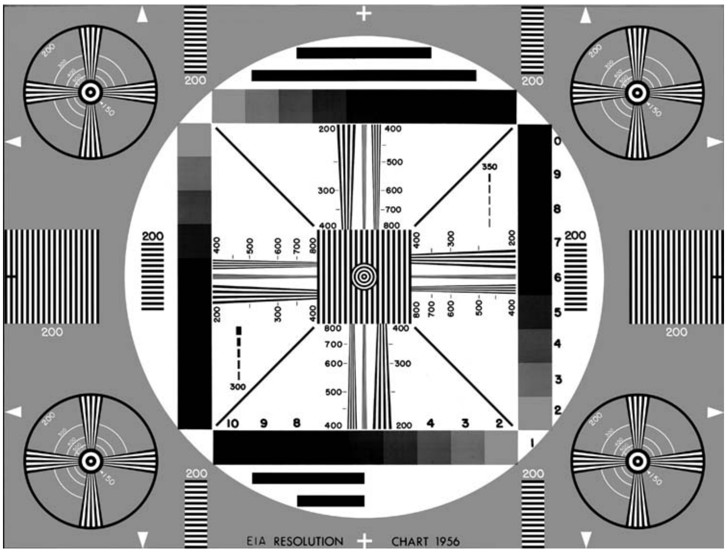
Analog Camera

Step 1 Adjust the drive parameters of the analog camera to optimal settings, which are usually default settings. Set other parameters of the analog camera to normal settings, for example, set the exposure setting to the automatic mode.

Step 2 Use the transmittance light box with the transmittance test light source produced by Image Quality Labs. Place the resolution test card EIA-1956 Resolution Chart in the card slot of the light box, and then turn on the light source control of the light box. Keep the default settings for the transmittance test light source with the illumination in the range of 80 lux ± 10 lux.

Step 3 Test the horizontal resolution as follows: Use the specialized A-frame with three-dimensional PTZ control to adjust the position of the analog camera and ensure that its optic axis is perpendicular to the surface of EIA-1956 Resolution Chart. Also, ensure that the EIA-1956 Resolution Chart falls within the preview image of the analog camera, as shown in Figure 1-4.

Figure 1-4 Preview image of the EIA-1956 Resolution Chart



Step 4 Fix the analog camera and three-dimensional PTZ. When the preview image is stable, use a video capture card or set up a digital video recorder (DVR) environment to capture the current preview image.

Step 5 Adjust the amplitude and focus the camera again for three times. Capture three pictures or take a 1-min video each time for further analysis.

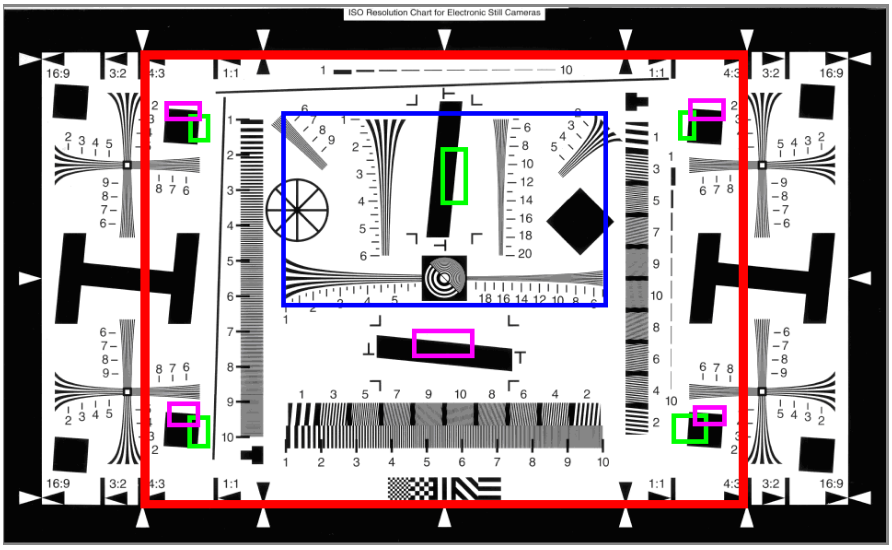
----End

1.1.6 Resolution Reading Method

- IP camera:
  - Read from low-frequency wedge-shaped line pairs, where five line pairs can easily be identified, to the high-frequency level. When five line pairs cannot be identified, the value in that position is the resolution value.
  - Use HYRes to read television lines (TVLs).

- Use Imatest to analyze the resolution values or Modulation Transfer Function (MTF) values of the photographed area in the red box in Figure 1-5. The green boxes highlight areas of the horizontal resolution values, the purple boxes highlight areas of the vertical resolution values; the boxes in the center highlight areas of the center resolution values, and other boxes highlight areas of the resolution values in different corners.

Figure 1-5 Preview image of the ISO12233 Chart with highlighted MTF areas where green boxes highlight areas of horizontal MTF values and purple boxes highlight areas of vertical MTF values



- Analog camera:
  - Read from low-frequency wedge-shaped line pairs, where four line pairs can easily be identified, to the high-frequency level. When four line pairs cannot be identified, the value in that position is the resolution value.
  - Use ResolutionCharRead to read TVLs.
  - Read nine values in total and use the maximum value.

1.1.7 Test Standard

NOTE

The resolution can be verified based on MTF and TVL. MTF tends to measure the edge sharpness and TVL focuses on the image resolving power. Although the two KPIs stand for different meanings, they can follow the same value standards in the following verification standard.

The verification standard is based on the identification of line pairs, as listed in Table 1-1.

Table 1-1 Major resolution KPIs (such as center resolution and horizontal resolution)

Resolution	Horizontal TVL		Vertical TVL		MTF	
	Center	Corner	Center	Corner	MTF50	MTF30
720P (1280 x 720)	700	500	650	500	-	-
1080P (1920 x 1080)	1050	650	900	650	-	-

Resolution	Horizontal TVL		Vertical TVL		MTF	
	Center	Corner	Center	Corner	MTF50	MTF30
3M	1100	800	1000	800	-	-
5M	1400	1000	1200	1000	-	-
8M	2100	1200	1500	1200	-	-
D1 (PAL)	540	-	-	-	-	-
960H (PAL)	720	-	-	-	-	-

1.2 Color Reproduction

1.2.1 Test Purpose

To test the color reproduction capability of an IP camera. As the light filter has a great impact on the test result, its model information shall be mentioned in the test data.

1.2.2 Test Equipment

- Light box
- Color Checker (24-patch) Chart, such as the Gretag Macbeth Color Checker
- Color temperature and illuminance meter

1.2.3 Test Software

Imatest

1.2.4 Test Environment

- The color temperature can be shifted among low, medium, and high, such as A light (2800 K), Day light (5000 K), Day light (6500 K), Day light (7500 K). For module IP cameras and consumer IP cameras, only 5000K and 6500K need to be focused on.
- The illumination is adjusted in the range of 600 lux ± 100 lux. Ensure ISO100 is used (and avoid overexposure in the white patch).
- The difference of brightness values on the surface of the chart is smaller than 20%.

1.2.5 Test Procedure

Step 1 Adjust the drive parameters of the IP camera to optimal settings. Set other photographing parameters of the IP camera to normal settings, for example, set both the white balance (WB) and exposure settings to the automatic mode.

Step 2 Adjust the light source and illumination following the verification environment requirements.

Step 3 Place the Color Checker Chart in the center in front of the light box. Adjust the position of the IP camera to ensure that the width of the chart in the preview image ranges from 500 pixels to 1500 pixels, as shown in Figure 1-6.

Figure 1-6 Preview image of the Color Checker Chart

Step 4 Take pictures when the preview image is stable.

Step 5 Use Imatest to analyze the pictures that are taken with the color space of sRGB and the exposure error rate smaller than 0.25, and get the saturation value as well as sigma values of ΔC corr and ΔE.

----End

1.2.6 Calculation Method

The CIEDE2000 formula for calculating the color difference is as follows:

$$\Delta E_{00}=\sqrt{\left(\frac{\Delta L'}{K_L S_L}\right)^2+\left(\frac{\Delta C'_{ab}}{K_C S_C}\right)^2+\left(\frac{\Delta H'_{ab}}{K_H S_H}\right)^2+R_T\left(\frac{\Delta C'}{K_C S_C}\right)\left(\frac{\Delta H'_{ab}}{K_H S_H}\right)}$$

Procedure:

Step 1 Calculate the values of **L***, **a***, **b***, and **C*$_{ab}$** in the CIELAB formula.

$$\begin{cases} L^* = 116\,f\,(Y/Y_0) - 16 \\ a^* = 500\left[f\,(X/X_0) - f\,(Y/Y_0)\right] \\ b^* = 200\left[f\,(Y/Y_0) - f\,(Z/Z_0)\right] \\ C^*_{ab} = \sqrt{a^{*2} + b^{*2}} \end{cases}$$

Step 2 Calculate **L'**, **a'**, **b'**, **C'**$_{ab}$, **h**$'_{ab}$, and **G**.

$$L' = L^*$$
$$a' = (1+G) \times a^*$$
$$b' = b^*$$
$$C'_{ab} = \sqrt{a'^2 + b'^2}$$
$$h_{ab}' = \arcsin(b'/a')$$
$$G = 0.5 \times \left(1 - \sqrt{\frac{\overline{C^*_{ab}}^7}{\overline{C^*_{ab}}^7 + 25^7}}\right)$$

G indicates the axis adjustment factor of the CIELAB color space.

Step 3 Calculate △**L**, △**C'**$_{\mathbf{ab}}$, and △**H'**$_{\mathbf{ab}}$.

$$\Delta L = L'_1 - L'_2$$
$$\Delta C'_{ab} = C'_{ab,1} - C'_{ab,2}$$
$$\Delta H'_{ab} = 2\sqrt{C'_{ab,1} \bullet C'_{ab,2}} \sin\left(\frac{\Delta h'_{ab}}{2}\right)$$

Step 4 Calculate **S**$_{\mathbf{L}}$, **S**$_{\mathbf{C}}$, **S**$_{\mathbf{H}}$, and **T**.

$$S_L = 1 + \frac{0.015\left(\overline{L'} - 50\right)^2}{\sqrt{20 + \left(\overline{L'} - 50\right)^2}}$$
$$S_C = 1 + 0.045\,\overline{C'_{ab}}$$
$$S_H = 1 + 0.015\,\overline{C'_{ab}}\,T$$

$$T = 1 - 0.017\cos\left(\overline{h'_{ab}} - 30°\right) + 0.24\cos\left(2\overline{h'_{ab}}\right) + 0.32\cos\left(3\overline{h'_{ab}} + 6°\right) - 0.20\cos\left(4\overline{h'_{ab}} - 63°\right)$$

If the hues of the two colors are in different quadrants, note the following: For example, if the hue angles of the standard color and sample color are 90° and 300° respectively, the arithmetic average is 195°, but the correct average is actually 15°. In calculation, you can check the absolute difference between two hue angles. If the difference is less than or equal to 180°, use the arithmetic average. However, if the difference is greater than 180°, you need to subtract 360° from the larger hue angle, then calculate the arithmetic average. Therefore, in the foregoing example, –60° (subtract 360° from 300°) should be used as the hue angle of the sample color, and the arithmetic average is 15°.

⊿C_{00} is illumination-independent. Its calculation method is similar to that of **⊿E_{00}**, but $(\Delta L'/K_L S_L)^2$c is required.

Saturation = 100% x $[(a_1{}^2 + b_1{}^2)^{1/2}] / [(a_2{}^2 + b_2{}^2)^{1/2}]$

a_1 and **b_1** are values after MobileCam processing. **a_2** and **b_2** are actual values of the color chart.

----End

1.2.7 Test Standard

Table 1-2 Test standard

Test Category	Resolution		
	CIF and D1	720P and 1080P	Greater than 3M
⊿C_{00} (avr)	< 5	< 5	< 5
⊿C_{00} corr max	<10	<10	<10
⊿ E_{00} (max)	< 15	< 15	< 15
Saturation	100–130	100–130	100–130

NOTE

Currently, there are two kinds of expectation towards saturation:

- The first kind is to get closer to true colors, and the corresponding test standard requires the saturation in the range of 100% ± *N*%.
- The second kind is to satisfy the subjective visual perception, and the corresponding verification standard requires slightly strong colors.

The first kind is mostly applied to foreign products in foreign countries. As the color saturation just deviates a bit from 100%, such products provide lighter colors and slightly foggy images. The second kind is mostly adopted by home products in China. With high color saturation, such products can ensure bright colors and achieve satisfactory subjective perception. Therefore, the test standard of the second kind is more popular now in China. For module IP cameras and consumer IP cameras, ⊿ E_{00}(max) does not need to be focused on.

1.3 White Balance

1.3.1 Test Purpose

To test the white reproduction capability of an IP camera in different color temperature scenarios.

1.3.2 Test Equipment

- Light box with light sources of low, medium, and high color temperature
- Color Checker (24-patch) Chart, such as the Gretag Macbeth Color Checker
- Color temperature and illuminance meter

1.3.3 Test Software

Imatest

1.3.4 Test Environment

- The color temperature can be transferred among low, medium, and high, such as A light (2800 K), Day light (5000 K), Day light (6500 K), Day light (7500 K).
- The illumination is adjusted in the range of 600 lux ± 100 lux.

1.3.5 Test Procedure

Step 1 Adjust the drive parameters of the IP camera to optimal settings. Set other photographing parameters of the IP camera to normal settings, for example, set both the WB and exposure settings to the automatic mode.

Step 2 Place the Color Checker Chart in the center in front of the light box. Adjust the position of the IP camera to ensure that the width of the chart in the preview image ranges from 500 pixels to 1500 pixels, as shown in Figure 1-7.

Figure 1-7 Preview image of the Color Checker Chart

Step 3 Adjust the light source to F (2500 K), in which scenario the illumination does not need to be adjusted. When the preview image is stable, take pictures and record the actual color temperature and illumination.

Step 4 Adjust the light source to TL84 (4000 K) and the illumination in the range of 600 lux ± 100 lux. When the preview image is stable, take pictures and record the actual color temperature and illumination.

Step 5 Adjust the light source to D65 (6500 K) and the illumination in the range of 600 lux ± 100 lux. When the preview image is stable, take pictures and record the actual color temperature and illumination.

Step 6 Adjust the light source to D75 (7500 K) and the illumination in the range of 600 lux ± 100 lux. When the preview image is stable, take pictures and record the actual color temperature and illumination.

Step 7 Use Imatest to analyze WB of the pictures that are taken, with the color space of sRGB and the exposure error rate smaller than 0.25.

----End

1.3.6 Calculation Method

Use Imatest to analyze the pictures that are taken in different color temperature scenarios to get the WB difference of each color patch. This verification standard is based on the maximum value of color patches 20–23 in the Color Checker (24-patch) Chart, excluding the values of color patches 19 and 24 among six gray patches.

1.3.7 Test Standard

Table 1-3 Test standard

Test Category		Resolution		
		CIF and D1	1.3M and 2M	Greater than 3M
AWB	D65 and TL84 light sources	⊿S < 0.10	⊿S < 0.10	⊿S < 0.10
	F light source	⊿S < 0.15	⊿S < 0.15	⊿S < 0.15

NOTE

For module IP cameras and consumer IP cameras, you only need to ensure that the white balance indicator meets the requirement for the D65 or D50 light source. For other light sources, the requirement is not mandatory. It depends on the subjective effect.

1.4 Gray Scale

1.4.1 Test Purpose

To test the dynamic range of an IP camera.

1.4.2 Test Equipment

- Light box
- Gray-scale chart of 20 scales, such as the Kodak Gray Scale Chart Q14
- Color temperature and illuminance meter

1.4.3 Test Software

None

1.4.4 Test Environment

- D65 light source is available with the illumination in the range of 600 lux ± 100 lux on the surface of the chart. Ensure that ISO100 is used.
- The difference of brightness values on the surface of the chart is smaller than 10%.

1.4.5 Test Procedure

Step 1 Adjust the photographing parameters of the IP camera to optimal settings.

Step 2 Place the IP camera in front of the Gray Scale Chart and ensure that the chart takes up at least 50% of the area in the preview image, as shown in Figure 1-8.

Figure 1-8 Preview image of the Kodak Gray Scale Chart Q14

Step 3 Take pictures when the preview image is stable.

----End

1.4.6 Calculation Method

Observe the pictures that are taken. Check whether there are adjacent gray scales that cannot be distinguished by naked eyes. Also, record the corresponding gray-scale level.

1.4.7 Test Standard

The gray-scale level shall be no lower than 18.

NOTE

To a great extent, the gray scale indicates the resolving power of images under various brightness conditions. A higher gray-scale level usually ensures higher resolving power. If the gray-scale level is too low, similar scenarios and objects cannot be distinguished under the corresponding brightness condition, and no object can be seen clearly as the bright region is too bright or overexposed and the dark region is too dark. In general, if the gray-scale level is too high, details in the bright and dark regions can be displayed properly, but the permeability of images is also reduced. Factors that are used in the brightness adjustment algorithm, such as the contrast, brightness, and Gamma, can have a great impact on the gray scales.

1.5 Signal-to-Noise Ratio

1.5.1 Test Purpose

To test the noise level of an IP camera.

1.5.2 Test Equipment

- Light box
- Color Checker (24-patch) Chart, such as the Gretag Macbeth Color Checker
- Color temperature and illuminance meter

1.5.3 Test Software

Imatest

1.5.4 Test Environment

- D65 light source is available with the illumination in the range of 600 lux ± 100 lux. Ensure that ISO100 is used.
- The difference of brightness values on the surface of the chart is smaller than 10%.

1.5.5 Test Procedure

Step 1 Adjust the drive parameters of the IP camera to optimal settings. Set other photographing parameters of the IP camera to normal settings, for example, set both the WB and exposure settings to the automatic mode.

Step 2 Adjust the light source and illumination following the verification environment requirements.

Step 3 Place the Color Checker Chart in the center in front of the light box. Adjust the position of the IP camera to ensure that the chart takes up about 70% of the area in the preview image, as shown in Figure 1-6.

Step 4 Take pictures when the preview image is stable.

Step 5 Use Imatest to analyze the pictures that are taken and get the noise level. Note that if a video is taken, capture five different key frames from a video and get the average value of the noise level.

----End

1.5.6 Calculation Method

$SNR = 20 \log_{10}((S_{19} – S_{24})/N_{22})$

In the formula, S_{19} and S_{24} indicate the signal brightness values of color patches 19 and 24, respectively; and N_{22} indicates the noise level of color patch 22.

In Imatest (3.8) or later versions, if **Noise display** is set to **Pixel SNR(dB)(20*log10(S/N))**, the SNR can be calculated directly.

1.5.7 Test Standard

Table 1-4 Test standard

Test Category	Resolution						
	CIF	D1	720P	1080P	Greater than 3M	5M	2160P
SNR (dB)	≥ 35	≥ 48	≥ 45	≥ 48	≥ 48	≥ 46	≥ 46

NOTE

According to *General Technical Requirements for Cameras Used in Security Video Surveillance-2011[1][1].3.16*, the SNR for 720p shall be no less than 45 dB. Currently, the module IP cameras and consumer IP cameras may use sensors less photosensible. Therefore, ensure the SNR is greater than or equal to 46 dB for 1080p.

1.6 Brightness Uniformity

1.6.1 Test Purpose

To test the imaging uniformity of an IP camera. The shadow is usually introduced by the lens.

1.6.2 Test Equipment

- Uniform light source
- Color temperature and illuminance meter

1.6.3 Test Software

Imatest

1.6.4 Test Environment

- Requirements for the background material are as follows:
  - D65/10° Lab values: 56.8, –0.6, and 0.7
  - Neutral 5 with the reflectivity of 0.70
  - RGB values: 122, 122, and 121
- The illumination of the uniform light source is adjusted in the range of 600 lux ± 100 lux.

1.6.5 Test Procedure

Step 1 Ensure that the uniform light source is not affected by other light sources. Adjust the drive parameters of the IP camera to optimal settings.

Step 2 Place the IP camera in front of the luminous surface of the uniform light source with a distance ranging from 2 cm to 5 cm and ensure that the preview image of the IP camera is the luminous surface of the uniform light source.

Step 3 Take pictures when the preview image is stable.

Step 4 Use Imatest to analyze the brightness uniformity values.

----End

1.6.6 Calculation Method

Shading value = (Brightness value of the darkest in four corners *Y*/Brightness value of the brightness in the center) x 100%

1.6.7 Test Standard

Table 1-5 Test standard

Test Category	Resolution			
	CIF	D1	720P and 1080P	Greater than 3M
Shading	≥ 70%	≥ 75%	≥ 80%	≥ 85%

1.7 Distortion or Geometrical Distortion

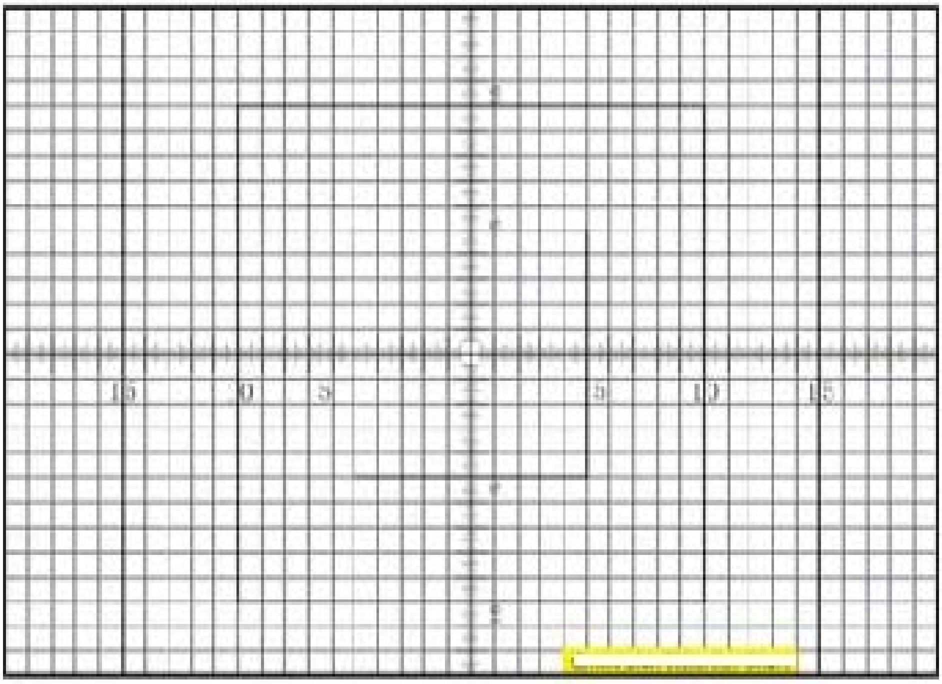
1.7.1 Test Purpose

To test the imaging geometrical distortion of an IP camera. Distortion is usually introduced by the lens.

1.7.2 Test Equipment

- Light box
- Color temperature and illuminance meter
- Geometrical distortion test chart, such as the Checkerboard Distortion Test Target for Microsoft© Lync™ Certification, as shown in Figure 1-9.

Figure 1-9 Checkerboard test chart



1.7.3 Test Software

Imatest

1.7.4 Test Environment

- D65 light source is available with the illumination in the range of 600 lux ± 100 lux on the surface of the chart. Ensure that ISO100 is used.
- The difference of brightness values on the surface of the chart is smaller than 10%.

1.7.5 Test Procedure

Step 1 Place the chart in front of the light box and ensure that the optic axis center of the IP camera is aligned at the center of the geometrical distortion test chart.

Step 2 Take pictures when the preview image is stable.

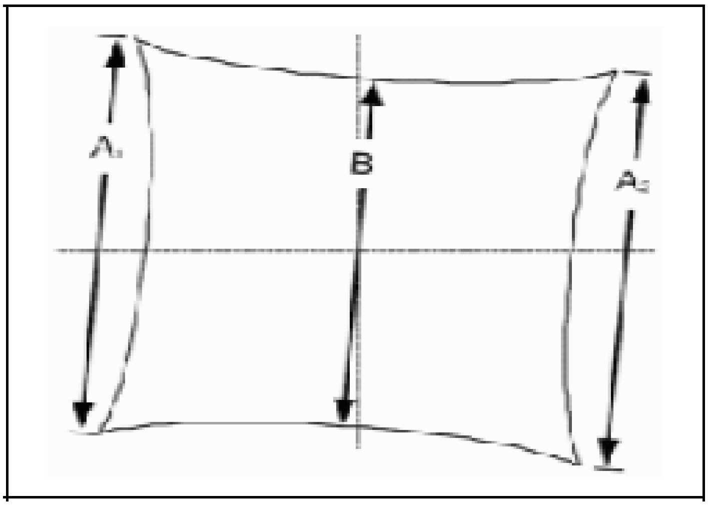
Step 3 Use Imatest to analyze the geometrical distortion values.

----End

1.7.6 Calculation Method

If geometrical distortion occurs, the relevant values can be calculated based on the picture that is taken with geometrical distortion, as shown in Figure 1-10.

Figure 1-10 Picture that is taken with geometrical distortion and used for calculating relevant values



Formulas are as follows:

- A = (A1 + A2)/2
- Distortion = 100 x (A – B)/B

1.7.7 Test Standard

Table 1-6 Test standard

Test Category	Resolution				
	CIF	D1	720P	1080P	Greater than 3M
Distortion	< 3%	< 2%	< 2%	< 1.50%	< 1%

1.8 Field of View

NOTE
This test item shall draw attention during product tests, but the result is used as a reference not as a KPI.

1.8.1 Test Purpose

To test the maximum field of view (FOV) of an IP camera.

1.8.2 Test Equipment

- Light box

- Color temperature and illuminance meter
- FOV Chart
- Ruler

1.8.3 Test Software

None

1.8.4 Test Environment

- D65 light source is available with the illumination in the range of 600 lux ± 100 lux on the surface of the chart. Ensure that ISO100 is used.
- The difference of brightness values on the surface of the chart is smaller than 10%.

1.8.5 Test Procedure

Step 1 Place the FOV Chart in front of the light box and ensure that the optic axis center of the IP camera is aligned at the center of the FOV Chart.

Step 2 Take pictures when the preview image is stable.

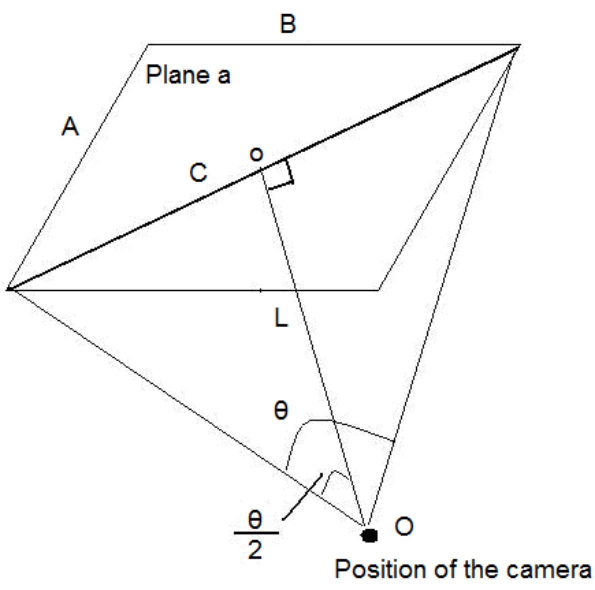
Step 3 Measure the distance *L* between the IP camera and chart, and the diagonal length *C* of the chart in the picture that is taken. Then, calculate the FOV value based on the measured values.

----End

1.8.6 Calculation Method

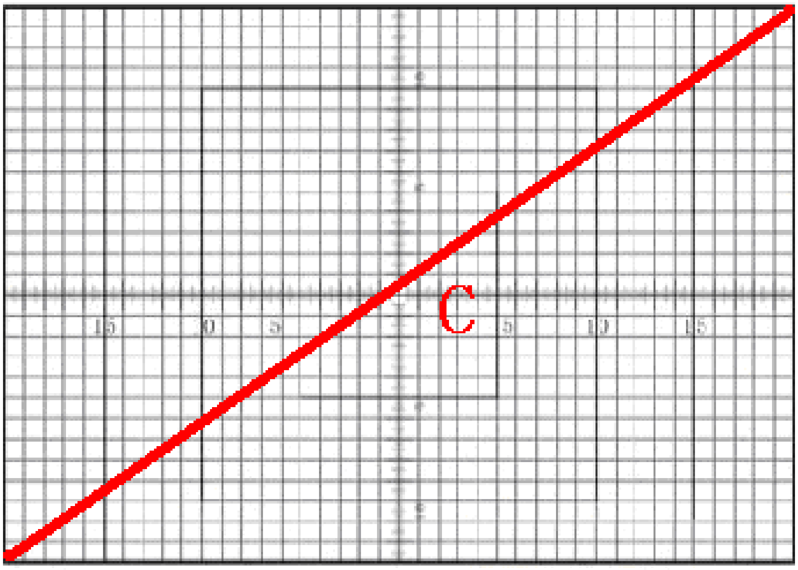
- As shown in Figure 1-11, the area where the picture is taken is plane *a*; the line perpendicular to plane *a* is *L*, which is the distance between the IP camera and FOV Chart; *A* and *B* indicate the maximum width and length of the picture that is taken, respectively; and *o* indicates the center of the FOV Chart.

Figure 1-11 Diagram 1 for calculating the FOV value



- Figure 1-12 shows the picture that is taken. Measure the diagonal length *C* of the chart in the picture, or calculate this length by using a formula. Also, measure the actual distance *L* between the IP camera and FOV Chart.

Figure 1-12 Diagram 2 for calculating the FOV value



- Assume that the FOV value is θ, formulas are as follows:

$$C = \mathrm{sqrt}\,(A^2 + B^2)$$

$$\theta = 2\mathrm{atan}\,(C/2L)$$

1.8.7 Test Standard

Table 1-7 Test standard

Test Category	Resolution				
	CIF	D1	720P	1080P	Greater than 3M
FOV (degree)	------	------	------	------	------

NOTE

As the FOV requirement may vary in different application scenarios of products, FOV values are not specified in this standard.

2 Scenarios

2.1 Image Edge

2.1.1 Test Purpose

To test whether the preview image of an IP camera is normal.

2.1.2 Test Equipment

- Normal light source
- Object in a bright color, such as red, blue, or yellow

2.1.3 Test Environment

Use the IP camera to capture pictures of the object in a bright color, and then observe the image quality of edges.

2.1.4 Test Procedure

Step 1 Observe the pictures of the object in a bright color that are taken by the IP camera.

Step 2 Observed the pictures to check whether the up, down, left, and right edges of these pictures contain any color that is inconsistent with the color of the object.

----End

2.1.5 Key Dimensions

Black edge and white edge

2.2 Static Scenario

2.2.1 Test Purpose

To test the image quality of an IP camera in a static scenario.

2.2.2 Test Equipment

- Normal light source

- Still and colorful static model, such as flowers and plants, dolls, and color cloths

2.2.3 Test Environment

Use the IP camera to film the static model, and then observe the image quality.

2.2.4 Test Procedure

Step 1 Observe the color saturation of the static model filmed by the IP camera.

Step 2 Check whether colors of the static model are properly reproduced, and whether colors are reproduced with correct RGB proportions and accordingly can be properly distinguished.

Step 3 Use the IP camera to film straight edges at a small angle to check whether aliasing occurs.

Step 4 Check whether the edges contain mixed colors.

Step 5 Change the color temperature to check whether color deviation occurs.

----End

2.2.5 Key Dimensions

- Definition, color reproduction, permeability, noise, aliasing, flare, blocking artifact, breathing, and false color.
- Whether blocking artifact easily occurs in black and flat regions, such as a black display screen or black clothes.
- Whether aliasing easily occurs at tilt angles.

2.3 Personage Scenario

2.3.1 Test Purpose

To test the image quality of an IP camera in a personage scenario.

2.3.2 Test Equipment

- Normal light source
- Person

2.3.3 Test Environment

Use the IP camera to film the person, and then observe the image quality.

2.3.4 Test Procedure

Step 1 Observe under the uniform light source and normal illumination to check whether the person's complexion is natural or distorted, whether the brightness is controlled properly, whether there is any overexposure, and whether upper and lower arms in the image are affected by the ringing effect.

Step 2 Observe whether the person's complexion is soft, whether details are clear, and whether the person looks stereoscopic.

----End

2.3.5 Key Dimensions

Definition, color reproduction, and permeability

2.4 Long Shot Scenario

2.4.1 Test Purpose

To test the image quality of an IP camera in a long shot scenario.

2.4.2 Test Equipment

No special equipment is required.

2.4.3 Test Environment

Use the IP camera to film in a long shot scenario, such as a long and narrow passageway. Then, observe the image quality.

2.4.4 Test Procedure

Observe the filming capability of the IP camera in the long shot scenario. Check whether the depth of field (DoF) is appropriate and whether distant details can be seen clearly.

2.4.5 Key Dimensions

Definition, permeability, DoF, and color reproduction

2.5 WDR Scenario

2.5.1 Test Purpose

To test the image quality of an IP camera in a WDR scenario.

2.5.2 Test Equipment

No special equipment is required.

2.5.3 Test Environment

- Use the IP camera to film in a region with significant brightness difference, such as a window, outside which the light is strong and inside which the light is weak. Then, observe the image quality.

- Place a strong light directly towards a solid object, and use the IP camera to monitor this object from another side to observe the image quality under bright and dark conditions.

WDR is typical in two types of application scenarios: one includes office buildings, office areas, and doorways of halls; the other includes hotel corridors and passageways. The former type is characterized by the larger bright region and brighter light source, while the bright region of the latter has a smaller area and lower brightness.

2.5.4 Test Procedure

Step 1 Observe the image quality with the WDR mode enabled and disabled to compare whether scenes in the bright and dark regions change, whether changes are great, and whether the overall brightness and brightness in the dark region are appropriate.

Step 2 Observe whether edges of the bright region contain purple edges.

----End

2.5.5 Key Dimensions

- Bright region detail, dark region detail, color reproduction, purple edge or green edge, permeability, noise, and smearing
- In WDR scenarios, the most important dimensions include faces and clothes details (including the color and texture), as well as smearing and following noise of the moving personage.

2.6 Low-Illumination Scenario

2.6.1 Test Purpose

To test the image quality of an IP camera in a low-illumination scenario.

2.6.2 Test Equipment

- Light box
- Small object to be placed in the light box
- Movable object, such as a pendulum

2.6.3 Test Environment

Use the IP camera to film in the light box, and then observe the image quality.

2.6.4 Test Procedure

Step 1 Adjust the illumination of the light box to 5 lux and observe the image quality of the IP camera. Then, lower the illumination to 1 lux, 0.5 lux, 0.2 lux, 0.1 lux, 0.01 lux, and lower. In the meantime, observe the image quality of the IP camera under conditions with different illumination values.

Step 2 Observe the overall brightness of the image to check whether the noise control takes effect and whether the image is obviously affected by blocking artifact and breathing.

Step 3 Record whether objects are distinguishable under specified illumination values, the quantity of noise, the size of granular noise, and whether the motion noise and smearing exist around the moving object.

----End

2.6.5 Key Dimensions

Brightness, definition, permeability, noise, blocking artifact, breathing, color reproduction, and smearing

2.7 Infrared Scenario

2.7.1 Test Purpose

To test the image quality of an IP camera in an infrared scenario.

2.7.2 Test Equipment

- Color temperature and illuminance meter
- Infrared lamp
- Laser rangefinder

2.7.3 Test Environment

Turn on the infrared lamp in an indoor low-illumination scenario and ensure that both the infrared lamp and IP camera face towards the same object. Use the IP camera to film the object and observe the image quality.

NOTE

- In this scenario, the day/night mode of the product to be tested shall be set to the automatic mode or the night mode.
- It shall be determined whether the frame loss mode is adopted in low-illumination scenarios. Generally, this test shall adopt the test mode without frame loss.

2.7.4 Scenario Selection

Indoor low-illumination scenario where the object is filmed by using the IP camera and infrared lamp

2.7.5 Key Dimensions

Definition, permeability, noise, brightness, bright region quality, dark region quality, exposure, and smearing

2.8 Complex Texture Scenario

2.8.1 Test Purpose

To test the image quality of an IP camera in a complex texture scenario.

2.8.2 Test Equipment

Object with complex texture, such as a piece of striped clothes, a stripe test chart, or a board.

2.8.3 Test Environment

Use the IP camera to film the object with complex texture, and then observe the image quality.

2.8.4 Test Procedure

Observe the image to check whether Y/C separation occurs and whether the image is blurry.

2.8.5 Key Dimensions

Definition and false color

2.9 Motion Scenario

2.9.1 Test Purpose

To test the image quality of an IP camera in a motion scenario.

2.9.2 Test Equipment

Moving object, such as a person or a pendulum

2.9.3 Test Environment

Use the IP camera to film the moving object, and then observe the image quality. The object can move in the following modes:

- The object moves from far to near.
- The object moves using two motion types: translation and rotation.
- The object moves at different speeds: fast and slow.

NOTE

If the IP camera is equipped with the stabilization function, the motion of the IP camera can also be tested.

2.9.4 Test Procedure

Step 1 Observe the definition and edge sharpness of the moving object.

Step 2 Observe whether the motion noise exists around the moving object and whether color retention occurs after the object moves.

----End

2.9.5 Key Dimensions

Subject definition, background definition, color retention, continuity, noise, smearing, blocking artifact, breathing, and edge flare

2.10 Light Variation Scenario (AE Convergence)

2.10.1 Test Purpose

To test the automatic exposure (AE) convergence capability of an IP camera, including the AE convergence speed and stability.

2.10.2 Test Equipment

- Light box or luminance box
- Spotlight or car lamp
- Baffle plate in a dark color

2.10.3 Test Environment

- Use the IP camera to film in the light box. Adjust the brightness of the light source to make it brighter or darker, and then observe the image quality.
- Use the IP camera to film in a normal scenario. When the preview image is stable, put a baffle plate in front of the lens to completely cover the image for about three seconds, and then remove the baffle plate. In the meantime, observe the image quality.
- Use the IP camera to film in an indoor scenario with the normal illumination. Turn off the light and wait until AE is stable. Then, turn on the light and wait until AE is stable.

2.10.4 Test Procedure

Step 1 Observe the duration that the image recovers after the light source of the light box changes or the baffle plate is removed from the lens.

Step 2 After the image recovers, observe whether oscillation (or brightness variation) occurs.

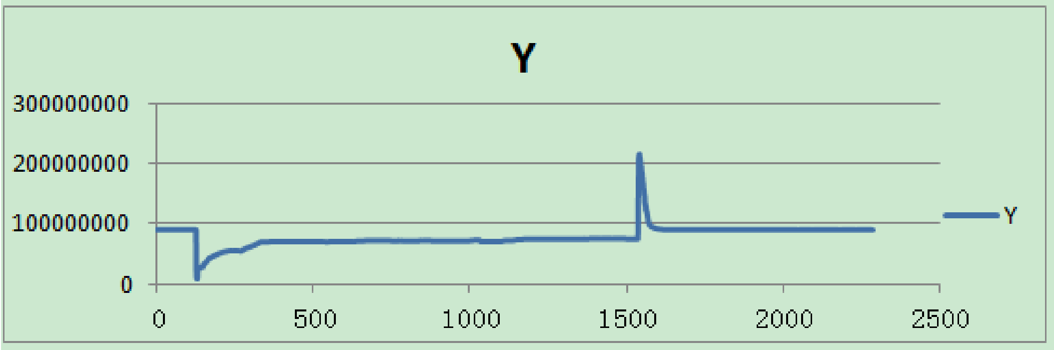
----End

2.10.5 Key Dimensions

AE convergence speed, AE convergence stability, AWB convergence speed, AWB convergence stability, blocking artifact, smearing, and bit rate fluctuation

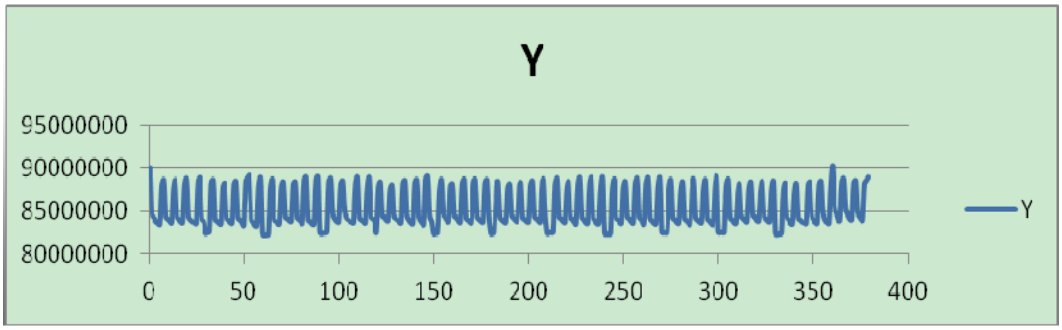
- Figure 2-1 shows an example of AE convergence.

Figure 2-1 AE convergence



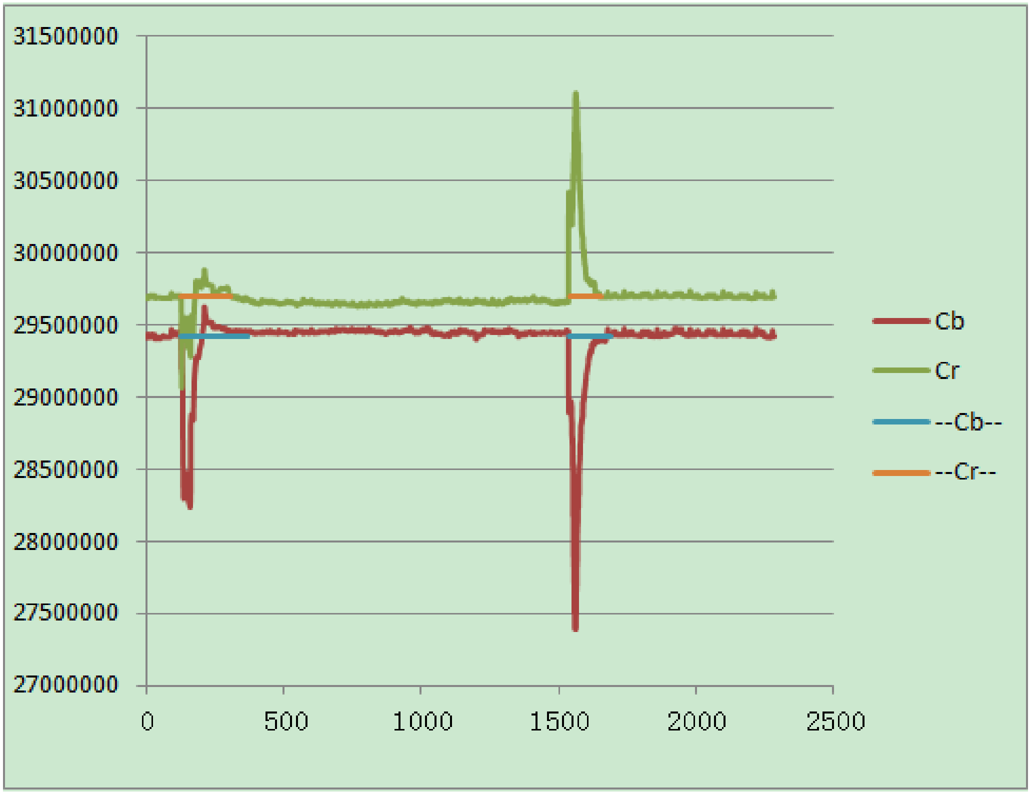
- Figure 2-2 shows an example of AE oscillation.

Figure 2-2 AE oscillation



- Figure 2-3 shows an example of AWB convergence.

Figure 2-3 AWB convergence



2.11 Highlight Scenario

2.11.1 Test Purpose

To test the image quality of an IP camera in a highlight scenario.

2.11.2 Test Equipment

Spotlight or car lamp

2.11.3 Test Environment

Use the IP camera to film objects around the highlight and ensure that the angle between the IP camera and highlight remains unchanged. Then, observe the image quality.

2.11.4 Test Procedure

Observe whether the objects around the highlight are distinguishable to check the highlight compensation (HLC) effect.

2.11.5 Key Dimensions

- Bright region quality, dark region quality, purple edge, permeability, halo size, and color reproduction
- Large-area single color scenario

2.12 Large-Area Single Color Scenario

2.12.1 Test Purpose

To test whether color deviation occurs in the neutral color region with the background in a large-area single color.

2.12.2 Test Equipment

Shade cloths in different colors, such as red, green, blue, yellow, light yellow, and gray

2.12.3 Test Environment

Place a large-area gray roller shutter in a position in parallel with the top of a desk. Place a Color Checker (24-patch) Chart vertically on the desk and ensure that the chart is not affected when the roller shutter is pulled down.

2.12.4 Test Procedure

Step 1 Select a shade cloth in a neutral color (such as gray) as the background. Pull down the large-area gray roller shutter to cover 30%, 50%, and 80% of the preview image and last for about three minutes each time. In the meantime, observe whether color deviation occurs in color patches 19–23 in the Color Checker (24-patch) Chart, and record the code stream in real time.

Step 2 Each time the roller shutter is removed, observe whether the image can quickly recover and turn gray.

Step 3 Change to another shade cloth in a different color and repeat steps 1 and 2.

Step 4 Use Imatest and the Color Checker (24-patch) Chart to analyze the color deviation level.

----End

2.12.5 Key Dimensions

Color reproduction

3 Outdoor Scenarios

3.1 Open Scenario

3.1.1 Test Purpose

To test the image quality of an IP camera in an open scenario.

3.1.2 Test Equipment

- Color temperature and illuminance meter
- Laser rangefinder

3.1.3 Test Environment

Use the IP camera to film in an open scenario, and then observe the image quality.

3.1.4 Scenario Selection

Square, rooftop of a low-rise building, tree, flower, and crowd, where the scenario is filmed by the IP camera under different weather conditions

3.1.5 Key Dimensions

Definition, brightness, permeability, DoF, color reproduction, noise, and aliasing

3.2 Outdoor AWB Scenario

3.2.1 Test Purpose

To test the image quality of an IP camera in an outdoor AWB scenario.

3.2.2 Test Equipment

Color temperature and illuminance meter

3.2.3 Test Environment

Use the IP camera to film in an outdoor scenario, and then observe the image quality.

3.2.4 Scenario Selection

Scenario with rich colors and various objects, such as roads, flowers and plants, and buildings, where the scenario is filmed by the IP camera in the daytime, generally from 6:00 to 20:00

3.2.5 Key Dimensions

Definition, permeability, and color reproduction

3.3 Outdoor WDR Scenario

3.3.1 Test Purpose

To test the image quality of an IP camera in an outdoor WDR scenario.

3.3.2 Test Equipment

Color temperature and illuminance meter

3.3.3 Test Environment

Use the IP camera to film in an outdoor WDR scenario, and then observe the image quality.

3.3.4 Scenario Selection

- In the daytime with strong light outdoors, place the IP camera in a lobby with the light turned off and use the IP camera to film the doorway where people enter the lobby from the outside.
- Place the IP camera in an outdoor scenario with bright light and film the indoor scenario where the light is darker through a glass door.

3.3.5 Key Dimensions

Bright region quality, dark region quality, purple edge, color reproduction, permeability, noise, and smearing

3.4 Outdoor Low-Illumination Scenario

3.4.1 Test Purpose

To test the image quality of an IP camera in an outdoor low-illumination scenario.

3.4.2 Test Equipment

Color temperature and illuminance meter

3.4.3 Test Environment

Use the IP camera to film in an outdoor low-illumination scenario, and then observe the image quality. In this scenario, the infrared lamp is not required by default and the test only verifies the processing effect of the product itself.

3.4.4 Scenario Selection

Three outdoor scenarios in the nighttime with the illumination ranging from 0.1 lux to 1 lux, where the light is uniform and objects are moving, for example, people are walking.

NOTE

Low-illumination conditions include:

- Moonlight level: literally means scenarios with only the moonlight, and generally refers to conditions with the illuminations higher than 0.5 lux.
- Astral level: literally means quite dark scenarios with only the starlight, and generally refers to conditions with the illuminations lower than 0.5 lux.

3.4.5 Key Dimensions

Definition, permeability, brightness, noise, color reproduction, and aliasing

3.5 Outdoor Motion Scenario

3.5.1 Test Purpose

To test the image quality of an IP camera in an outdoor motion scenario.

3.5.2 Test Equipment

Color temperature and illuminance meter

3.5.3 Test Environment

Use the IP camera to film moving objects in an outdoor scenario, and then observe the image quality.

3.5.4 Scenario Selection

Objects move at a high, medium, or low speed:

- High speed: vehicles passing an overpass on a highway
- Medium speed: vehicles accessing the entrance and exit of a company
- Low speed: pedestrians walking at normal speeds

3.5.5 Key Dimensions

Definition, edge flare, smearing, color retention, noise, and blocking artifact

3.6 Outdoor Infrared Scenario

3.6.1 Test Purpose

To test the image quality of an IP camera in an outdoor infrared scenario.

3.6.2 Test Equipment

- Color temperature and illuminance meter
- Infrared lamp

3.6.3 Test Environment

Turn on the infrared lamp in an outdoor scenario and ensure that both the infrared lamp and IP camera face towards the same object. Use the IP camera to film the object and observe the image quality.

3.6.4 Scenario Selection

Outdoor scenario in the nighttime with the astral level and the illuminations lower than 0.5 lux, where the object is filmed by using the IP camera and infrared lamp

3.6.5 Key Dimensions

Definition, permeability, noise, brightness, bright region quality, dark region quality, overexposure, and smearing

3.7 Outdoor HLC Scenario

3.7.1 Test Purpose

To test the image quality of an IP camera in an outdoor HLC scenario.

3.7.2 Test Equipment

- Color temperature and illuminance meter
- Car
- Strobe light

3.7.3 Test Environment

Use the IP camera to film in an outdoor HLC scenario, and then observe the image quality.

3.7.4 Scenario Selection

In an outdoor scenario in the nighttime, turn on headlights of the car and use the IP camera to film the license plate. Properly adjust the aperture of the lens and brightness of the headlights. The car can move or stay still. If the car is moving, use the strobe light to produce some light for the license plate.

3.7.5 Key Dimensions

Bright region detail, dark region detail, halo size, color reproduction, and blocking artifact

4 Household Consumer IP Cameras

4.1 Indoor Scenario

4.1.1 Test Purpose

To test the effect of the household consumer IP camera under normal illumination indoors.

4.1.2 Test Equipment

Chroma meter, laser infrared distance meter

4.1.3 Test Environment

Use a household consumer IP camera to take photos under normal illumination indoors from a top or front view and observe the image effect.

4.1.4 Scenario Selection

Living room scenario: the photo frame, sofa, flower, green plant, desk, chair, doll, and also a moving person

4.1.5 Key Dimensions

Quick start time, definition, brightness, contrast, color reproduction, noise, aliasing, blocking artifact, and respiratory effect

4.2 Indoor Light Source Scenario

4.2.1 Test Purpose

To test the effect of the household consumer IP camera under light sources at different color temperatures indoors.

4.2.2 Test Equipment

Chroma meter, laser infrared distance meter

4.2.3 Test Environment

Use an IP camera to take photos at night, turn on light sources at different color temperatures, and observe the image effect.

4.2.4 Scenario Selection

Living room scenario: the photo frame, sofa, flower, green plant, desk, chair, doll, and also a moving person. You are advised to perform the test at night, using light sources at different color temperatures.

4.2.5 Key Dimensions

Quick start time, definition, brightness, contrast, color reproduction, noise, aliasing, blocking artifact, and respiratory effect

4.3 Indoor WDR Scenario

4.3.1 Test Purpose

To test the effect of the household consumer IP camera in an indoor WDR scenario.

4.3.2 Test Equipment

Chroma meter

4.3.3 Test Environment

Test the effect of the household consumer IP camera in an indoor WDR scenario and observe the image effect.

4.3.4 Scenario Selection

- Install the IP camera at the door which has windows nearby to simulate a doorbell scenario. The IP camera takes snapshots of the person who walks to the doorway.
- Install the IP camera indoors. There is a floor window or balcony and sufficient outdoor light as well as a person walking in the room.

4.3.5 Key Dimensions

Quick start time, bright and dark region effect, color reproduction, contrast, definition, noise, smearing, blocking artifact, and respiratory effect

4.4 Indoor Infrared Scenario

4.4.1 Test Purpose

To test the effect of the household consumer IP camera in an indoor infrared scenario.

4.4.2 Test Equipment

Chroma meter

4.4.3 Test Environment

Use the IP camera to take photos in the indoor low illumination scenario and observe the image effect. By default, infrared light is used for light compensation. Evaluate the image processing effect when the image is switched to black and white.

4.4.4 Scenario Selection

Indoor night scenario where the room light is turned off and infrared light is used and there is a moving object (for example, a walking person)

4.4.5 Key Dimensions

Quick start time, definition, contrast, brightness, noise, aliasing, blocking artifact, and respiratory effect

4.5 Indoor Convenience Store Scenario

4.5.1 Test Purpose

To test the effect of the household consumer IP camera in a convenience store indoors.

4.5.2 Test Equipment

Chroma meter

4.5.3 Test Environment

Test the effect of the household consumer IP camera in a convenience store indoors and observe the image effect.

4.5.4 Scenario Selection

Convenience store scenario where the colors and textures of goods are rich, the mixed light sources are rich, and there are people walking in and out

4.5.5 Key Dimensions

Quick start time, definition, contrast, brightness, color reproduction, noise, aliasing, blocking artifact, and respiratory effect

5 Data Evaluation and Application

5.1 Subjective Test Method for the Image Quality Based on Five Points

Table 5-1 Subjective test table for the image quality based on five points

Point	Level	Five-Level Quality Standard (Positive)	Five-Level Damage Standard (Negative)
5	Excellent	The image quality is excellent and very satisfactory.	The image contains no detectable damage or interference.
4	Good	The image quality is good and satisfactory.	The image contains slightly detectable damage or interference, but not annoying.
3	Medium	The image quality is common and acceptable.	The image contains obvious and detectable damage or interference, which is annoying.
2	Bad	The image quality is bad and barely acceptable.	The image contains less severe damage or interference, which is very annoying.
1	Poor	The image quality is poor and unacceptable.	The image contains severe damage or interference, which totally blocks the image.

An expert team consisting of professionals and non-professionals shall be set up to conduct the evaluation. It is recommended that the number of participants range from five to twelve. During the evaluation, the test personnel can discuss only the test process but not the test results, that is, they can discuss the test items but not the image quality. Then, the test personnel need to score each test item based on five points. During the scoring, the test personnel shall score the image quality based on the preceding positive and negative standards, and extend the score to one decimal point for further correction. The positive or neutral test dimensions, such as the definition and color reproduction, can be scored based on the five-level quality standard in Table 5-1. The negative test dimensions, such as the denoising effect, deinterlacing effect, and Y/C crosstalk, can be scored based on the five-level damage standard in Table 5-1.

The test personnel can also correct the test results after scoring the test items based on Table 5-1, as the test scores are extended to one decimal point. For example, after checking a video, the test personnel consider that the image quality is common and score it 3 out of 5. Then, after checking several videos, the test personnel may consider that the score of the former video can be higher and correct the score to 3.2. During the correction, the test personnel need to take into account the importance of scenarios in practical application and correct the scores properly.

During the subjective evaluation of the image quality, if the test personnel discover any obvious defect, such as aliasing or discontinuity at the edges for the image of moving objects, they need to reduce the score of the corresponding test dimension based on the defect and even reduce the score to the lowest point.

The test personnel can score a test item accurate to one decimal point and keep two decimal points for the final score.

Black box testing is required for all products to be tested. The test personnel cannot specify or imply any product or product module during the evaluation, but shall name the products to be tested using codes, such as A, B, and C. After the evaluation, the test personnel can then discuss the specific products and product models.

The evaluation can be summarized as follows:

- Products in black boxes
- Test personnel, including five to twelve participants of professionals and non-professionals
- Five points in total based on rough impression
- Score correction based on specific scenarios with the score accurate to 0.1
- Average score summary with the score accurate to 0.01 (Note that the test result is the final evaluation result.)

5.2 Subjective Dimension Evaluation Based on Five Points

Table 5-2 Table of subjective dimension evaluation based on five points

No.	Test Dimension	Key Dimension Reference	Scoring Method (0 ≤ Score ≤ 5. For Reference Only)
1	Definition	Texture of still and moving objects in the bright and dark regions	• Image aliasing occurs (although the lines are clear, they are not the original image content): –0.1. The image looks artificial: –0.2. No bonus items. • During motion, the moving object is blurred: –0.2. During motion, the static background is blurred: –0.3. The absence of the phenomena is rewarded with the corresponding bonus points. • The detail of the bright region is good (can be seen clearly): +0.1. The detail of the dark region is good (can be seen clearly): +0.1.

No.	Test Dimension	Key Dimension Reference	Scoring Method (0 ≤ Score ≤ 5. For Reference Only)
			The absence of the phenomena will cause the loss of the corresponding bonus points. • Edge ghosting (including white borders): –0.2. No bonus items. • The image is completely irrecognizable: –5. • The human face is irrecognizable or difficult to recognize: –0.2. The human face is recognizable: +0.2. The license plate is irrecognizable: –0.1. The license plate is recognizable: +0.1. • Other factors (The standard must be modified in a timely manner before being applied.)
2	Contrast	Local contrast and overall contrast	• Good local contrast (the bright region is not overexposed and the dark region is bright enough): +0.2. The local contrast is low: –0.2. • Good overall contrast: +0.2. Poor overall contrast: –0.2. • Totally invisible image: –5
3	Denoising	Image noise size	• The background image cannot be distinguished due to noise: –0.2. • Obvious granular noise: –0.1. Scattered noise: –0.1. • Striped chrominance noise: –0.2 • (Special item for coding) Cross noise: –0.2 • Large quantity of noise: –0.1 • Clean image: +0.1
4	Color reproduction	WB (reproduction of gray), saturation, and color deviation	• Overall color deviation: –0.5 • Other colors in the gray region (WB): –0.2 • Color deviation of gray due to a large-area pure color: –0.1 for each spot • Color deviation due to mixed light sources: –0.1 • Colors too light: –0.1 • Color deviation that can be distinguished by eyes: complexion, –0.3; sky, –0.2; leaves, –0.3.
5	Aliasing	Edge smoothness	The pixels of aliasing can be distinguished by visual inspection: –1 for each pixel
6	Flare	Bright and dark changes in the whole image or at the edges of the image	• Obvious AE flare: –0.5 • Obvious AWB flare: –0.5

No.	Test Dimension	Key Dimension Reference	Scoring Method (0 ≤ Score ≤ 5. For Reference Only)
			• Severe flare of edges or lines: –0.3
7	False color	Colors that the original image does not contain appear among dense stripes. Excluding the purple edge	• Full-screen moire: –0.5 • False color flare: –0.2 • The proportion of color lines to texture lines is 1:1: –0.5
8	Blocking artifact	Image quality loss due to a large quantization step, especially referring to the mosaic effect in a single or suspended static image	• Large size of blocks: –0.3 • A large number of blocks: –0.2
9	Breathing	Accumulative damage due to image inter-fame reference. Different from blocking artifact, breathing is a dynamic effect, such as dynamic refresh in the continuously played image.	• The image takes up the full screen: –0.3 • Blocks are frequently refreshed in the image: –0.3
10	Smearing	Color retention in the background after an object moves; or the edge or texture of the background image appears on the moving object	• Background edge or line on the moving object: –0.2 • Color retention behind the moving object: –0.3 • Color retention: –0.2 • Large quantity of noise that appears only after the object moves: –0.1
11	Complexion reproduction	A special item of color reproduction, especially referring to reproduction of complexion	• Complexion distortion and color deviation: –0.5 • Complexion too light or too saturated: –0.2
12	Bright region detail	A special item of definition, exclusively used for evaluation of the bright region detail	• The bright region is too bright and objects are undistinguishable: –0.3 • The slightly bright region can be suppressed and objects are distinguishable: +0.2 • The slightly bright region losses some details and objects are hardly distinguishable: –0.2
13	Dark region detail	A special item of definition, exclusively used for evaluation of the dark region detail	• The dark region is too dark and objects are undistinguishable: –0.3 • The slightly dark region can be improved and objects are distinguishable: +0.2 • The slightly dark region losses some details and objects are hardly distinguishable: –0.2
14	Purple edge	Purple that appears at the edges of the bright region	• Point light source, the purple edge of which is wider than the light source diameter based on visual inspection: –0.1 for every 20% • Area light source, the purple edge width of which is checked based on visual

No.	Test Dimension	Key Dimension Reference	Scoring Method (0 ≤ Score ≤ 5. For Reference Only)
			inspection: –0.1 for every two pixels • Object under direct radiation of the highlight, the purple edge width of which is checked based on visual inspection: –0.1 for each pixel • Large-area purple that appears in the image: –0.3
15	Brightness	A special item of definition, exclusively used for the brightness in the slightly dark region	• The brightness of the whole image is close to the scenery that can be seen by eyes with the normal illumination: +0.2 • The brightness of the image is slightly low and some objects are invisible: –0.2. • The image is too dark: –0.2. • The image is too bright: –0.1

5.3 Subjective Scenario Evaluation

During the evaluation of subjective dimensions, the test personnel need to score each dimension separately in each scenario, average the scores of all dimensions in a scenario, and use this average score as the test result of this scenario. Then, they can apply weighting to the average score of all scenarios and get the weighted score of the full scenarios, which is also the total score. Table 5-3 provides an example of the evaluation table that can be used by the test personnel.

Table 5-3 Table of subjective scenario evaluation

Test Dimension	Product A	Product B	Remarks
Static scenario	5.0	5.0	-
Personage scenario	5.0	5.0	-
Long shot scenario	5.0	5.0	-
WDR scenario	5.0	5.0	-
Low-illumination scenario	5.0	5.0	-
Complex texture scenario	5.0	5.0	-
Motion scenario	5.0	5.0	-
Light variation scenario (AE convergence)	5.0	5.0	-
Highlight scenario	5.0	5.0	-
Open scenario	5.0	5.0	-

Test Dimension	Product A	Product B	Remarks
Outdoor AWB scenario	5.0	5.0	-
Outdoor low-illumination scenario	5.0	5.0	-
Outdoor motion scenario	5.0	5.0	-
Outdoor HLC scenario	5.0	5.0	-
Weighted averaging of key dimensions	-	-	-

5.4 Data Results and Application

Table 5-4 Example of data results and application

Result Rating	Conclusion	Single Dimension	Weighting of All Dimensions	Weighting of Key Dimensions	Remarks
Grade A: competitive product	Passed	≥ 3.0	Higher than the benchmark	Higher than the benchmark	All standards are met.
Grade B: qualified product in terms of the image quality	Passed	≥ 3.0	Higher than the benchmark	-	All standards are met.
Grade C: unqualified or uncompetitive product	Failed	-	Lower than the benchmark	Lower than the benchmark	Only one standard is met.

- The corresponding benchmark is formulated based on version test strategies before the evaluation.
- The single dimension refers to each subjective dimension of the evaluation.

6 Appendix

Table 6-1 lists the equipment and software requirements.

Table 6-1 Equipment and software requirements

Equipment or Software	Requirement	Remarks
Imatest	Recommended versions: Imatest 3.6 and later versions	-
Light box	Light sources: D50, D65, D75, and A/F	-
Chart	ISO12233, Gretag Macbeth Color Checker, Kodak Gray Scale Chart Q14, and Checkerboard Distortion Test Target	-
Luminance box	LV0–LV17 and 0.1 step	-
Color temperature and illuminance meter	CL200 and T10	-