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**Technical requirements and measurement methods for
digital cinema LED auditorium**

数字电影 LED 影厅技术要求和测量方法

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Technical requirements and measurement methods for digital cinema LED auditorium

1 Scope

This document specifies the optical and acoustic technical requirements and corresponding measurement methods for digital cinema LED auditoriums.

This document applies to the operation and maintenance, testing and certification, quality supervision, technical management and installation, commissioning, acceptance of relevant equipments of digital cinema LED auditoriums.

2 Normative references

The contents of the following documents constitute essential clauses of this document through normative references in the text. Among them, for dated references, only the version corresponding to that date applies to this document; for undated references, the latest version (including all amendments) applies to this document.

GY/T 311-2017 Technical requirements and methods of measurement of audio-visual environment for cinema

GY/T 312-2017 Cinematography - B-chain electro-acoustic response of motion-picture control rooms and indoor theatres - Specifications and measurements

3 Terms and definitions

The following terms and definitions apply to this document.

3.1

Digital cinema LED projection system

A system used to realize digital movie program decoding and playback and LED digital projection, which is mainly composed of digital movie playback server, LED controller, LED display screen, sound reproduction system.

3.2

Digital cinema LED auditorium

An auditorium that uses a digital cinema LED projection system for movie projection.

3.3

Electro-optic transfer characteristic

The relationship between the input code value and the display brightness of the LED display, which is expressed by a characteristic value.

3.4

Stereoscopic extinction ratio

The ratio -- of the left eye (right eye) image brightness to the crosstalk light and ambient light, which is used to measure the left eye (right eye) image brightness's immunity to crosstalk light and ambient light.

4 Abbreviations

The following abbreviations apply to this document.

HDR: High Dynamic Range

LED: Light-Emitting Diode

SDR: Standard Dynamic Range

5 Composition of digital cinema LED auditorium

The digital cinema LED auditorium consists of a digital cinema LED projection system and other auxiliary systems. The digital cinema LED projection system mainly consists of a digital cinema playback server, an LED controller, an LED display screen, a sound reproduction system, as shown in Figure 1.

- Receiving angle: $\leq 1^\circ$;
- Accuracy: $\leq \pm 2\%$.

7.1.4 Spectroradiometer

The spectroradiometer shall meet the following requirements:

- Wavelength range: 380 nm ~ 780 nm;
- Measurement bandwidth: ≥ 2.5 nm ~ 20 nm;
- Receiving angle: $\leq 1^\circ$;
- Chromaticity accuracy x, y: $\leq \pm 0.002$.

7.1.5 Reflectivity tester

The reflectivity tester shall meet the following requirements:

- It can measure specular reflectivity and diffuse reflectivity;
- Illumination: d/8 integrating sphere structure (diffuse illumination);
- Integrating sphere size: $\geq \varnothing 54$ mm;
- Light source: Pulse xenon lamp, quantity ≥ 2 , can simulate standard illuminants A, C, D50, D65, etc.;
- Wavelength range: ≥ 360 nm ~ 740 nm;
- Reflectivity measurement range: $\geq 0\%$ ~ 175%;
- Display resolution: 0.01.

7.1.6 Noise signal generator

It shall meet the requirements of 5.2.4 of GY/T 311-2017.

7.1.7 Measurement microphone

It shall meet the requirements of 5.2.5 of GY/T 311-2017.

7.1.8 Sound level meter

It shall meet the requirements of 5.2.6 of GY/T 311-2017.

7.1.9 Filter

It shall meet the requirements of 5.2.7 of GY/T 311-2017.

7.2.2.2 HDR

Measurement signal with signal encoding value ($X'' = 2524$, $Y'' = 2546$, $Z'' = 2583$).

7.2.3 Black field measurement signal**7.2.3.1 SDR**

Measurement signal with signal encoding value ($X' = 122$, $Y' = 128$, $Z' = 125$).

7.2.3.2 HDR

Measurement signal with signal encoding value ($X'' = 60$, $Y'' = 62$, $Z'' = 65$).

7.2.4 Red field measurement signal**7.2.4.1 SDR**

Measurement signal with signal encoding values ($X' = 2901$, $Y' = 2171$, $Z' = 100$).

7.2.4.2 HDR

Measurement signal with signal encoding values ($X'' = 2234$, $Y'' = 1925$, $Z'' = 68$).

7.2.5 Green field measurement signal**7.2.5.1 SDR**

Measurement signal with signal encoding values ($X' = 2417$, $Y' = 3493$, $Z' = 1222$).

7.2.5.2 HDR

Measurement signal with signal encoding values ($X'' = 1988$, $Y'' = 2387$, $Z'' = 1327$).

7.2.6 Blue field measurement signal**7.2.6.1 SDR**

The measurement signal with signal encoding value ($X' = 2014$, $Y' = 1416$, $Z' = 3816$).

7.2.6.2 HDR

The measurement signal with signal encoding value ($X'' = 1871$, $Y'' = 1525$, $Z'' = 2565$).

7.2.7 “Black to white” grayscale measurement signal**7.2.7.1 SDR**

The measurement signal is divided into 10 groups of images. The signal encoding value requirements are as shown in Table 3.

- a) Ambient temperature: 15 °C ~ 35 °C;
- b) Relative humidity: 10% ~ 90%;
- c) Atmospheric pressure: 86 kPa ~ 106 kPa;
- d) Voltage amplitude: 220 V ± 10 V AC;
- e) Nominal frequency: 50 Hz.

7.3.2 Measurement conditions

The measurement conditions are as follows:

- a) All measurements shall be carried out in the normal viewing environment of the auditorium;
- b) All equipment shall be in normal and stable working state, or configured according to the measurement requirements;
- c) All measurement signals shall be played and output to the LED display screen by the digital movie playback server;
- d) The measurement of the optical system should be carried out within the range of qualified color reproduction at the center of the LED display screen;
- e) When measuring the optical system, it shall be carried out after the light output of the LED display screen is stable (thermal stabilization time is not less than 20 minutes) and the stereo projection equipment is stable (stereo projection equipment is exposed to light for not less than 15 minutes);
- f) When measuring the optical system, the optical measuring instrument is set up at the center of the seating area of the auditorium, 1.15 m above the selected seat floor; the measuring lens is aimed at the center of the LED display screen and has a clear focus;
- g) When measuring the stereo projection optical system, the stereo glasses are placed horizontally in front of the lens of the optical measuring instrument; the lens shall be perpendicular to the measurement axis and not block the instrument measurement;
- h) After each time the acoustic measurement equipment is turned on, the system shall be calibrated before the corresponding acoustic measurement can be carried out;
- i) When measuring the projection acoustic system, the measurement microphone is set up at a height of 1.15 m from the selected seat floor in the auditorium seating area. The measurement microphone points to the screen and tilts upward at a 45° angle. If the measurement microphone is lower than the seat back height, the

measurement microphone shall be appropriately raised and exceed the seat back height by about 0.15 m;

- j) When measuring the projection acoustic system, the spectrum analyzer/reverberation time meter shall be placed outside the auditorium to be measured, to avoid the noise emitted by the measuring instrument itself affecting the measurement results; at the same time, avoid artificial noise in the auditorium to affect the measurement results.

7.4 Measurement steps

7.4.1 Display resolution

The measurement steps are as follows:

- a) Projection resolution measurement signal;
- b) Check whether the pixels of the LED display screen and the pixels of the measurement signal correspond one by one; meanwhile it can fully display the received image signal.

7.4.2 Center point brightness

The measurement steps are as follows:

- a) Turn on the spectroradiometer;
- b) Project the white field measurement signal;
- c) Measure and record the white field center point brightness value of the LED display;
- d) Measure and record the white field center point brightness value of the LED display, at the center seats of the first and last rows of the audience area, and the leftmost and rightmost seats of the middle row.

7.4.3 Full screen brightness mean

The measurement steps are as follows:

- a) Turn on the imaging brightness meter;
- b) Project the white field measurement signal;
- c) Measure and record the full screen brightness mean of the LED display.

7.4.4 Brightness uniformity (module)

The measurement steps are as follows:

7.4.9.1 SDR electro-optical conversion characteristics

The measurement steps are as follows:

- a) Turn on the spectroradiometer;
- b) Display the "black to white" grayscale measurement signal and the "black to dark gray" grayscale measurement signal, respectively;
- c) Measure the brightness value of the center point of each grayscale;
- d) Use the least squares method to fit the curve power value between the image signal encoding value and the image brightness value, which is gamma.

7.4.9.2 HDR electro-optical conversion characteristics

The measurement steps are as follows:

- a) Turn on the spectroradiometer;
- b) Project the "black to white" grayscale measurement signal and the "black to dark gray" grayscale measurement signal, respectively;
- c) Measure the brightness value of the center point of each grayscale;
- d) Calculate the percentage -- of the measured brightness value of each grayscale center point TO the reference output brightness Y corresponding to the grayscale measurement signal encoding value in Table 4 and Table 6.

7.4.10 Brightness of the center point of stereoscopic projection

The measurement steps are as follows:

- a) Turn on the spectroradiometer;
- b) Set the LED display screen to stereoscopic projection mode; use stereoscopic projection equipment;
- c) Display white field measurement signals for both eyes at the same time;
- d) Measure the brightness value of the left eye white field center point L_l and the brightness value of the right eye white field center point L_r , through the left and right lenses of the stereo glasses, respectively;
- e) Calculate and record the brightness of the stereoscopic projection center point L of the LED display screen according to formula (3);

$$L = (L_l + L_r)/2 \dots\dots\dots (3)$$

- b) Set the LED display screen to stereo projection mode; use stereo projection equipment;
- c) Display the white field signal to the left and right eyes at the same time;
- d) Measure and record the white field chromaticity coordinates of the stereo projection center point of the LED display screen, through the left and right lenses of the stereo glasses, respectively.

7.4.14 Extinction ratio of stereoscopic projection

The measurement steps are as follows:

- a) Turn on the spectroradiometer;
- b) Set the LED display to stereoscopic projection mode; use stereoscopic projection equipment;
- c) Project the white field measurement signal to the left eye; project the black field measurement signal to the right eye;
- d) Through the left lens of the stereo glasses, measure and record the brightness value of the center point of the white field L_{lw}^I ;
- e) Through the right lens of the stereo glasses, measure and record the brightness value of the center point of the black field L_{rb}^I ;
- f) Project the black field measurement signal to the left eye; project the white field measurement signal to the right eye;
- g) Through the left lens of the stereo glasses, measure and record the brightness value of the center point of the black field L_{lb}^I ;
- h) Through the right lens of the stereo glasses, measure and record the brightness value of the center point of the white field L_{rw}^I ;
- i) Calculate and record the left eye's stereoscopic projection extinction ratio I_l according to formula (7);

$$I_l = L_{lw}^I : L_{lb}^I \cdots \cdots \cdots (7)$$

Where:

7.4.15.2 Specular reflectivity

The measurement steps are as follows:

- a) Turn off the LED display;
- b) Use a reflectivity tester to measure close to the LED display;
- c) The measurement shall be carried out at multiple locations on the LED display;
- d) Calculate the average value of all measurement results for each wavelength; draw a specular reflectivity average curve;
- e) Record the worst value of the specular reflectivity of the LED display, as the specular reflectivity measurement result.

7.4.16 Pixel visibility

The measurement steps are as follows:

- a) Project the resolution measurement signal;
- b) Check in the first row of seats, to see if the pixel structure of the LED display and the obvious dark area between pixels can be observed.

7.4.17 Image zoom

The measurement steps are as follows:

- a) Project the resolution measurement signal;
- b) Check in the first row of seats, to see if the image scaling artifacts of the LED display can be observed.

7.4.18 Sub-pixel spatial consistency

The measurement steps are as follows:

- a) Project the resolution measurement signal;
- b) Check in the first row of seats, to see if the geometric anomalies of the sub-pixel spatial arrangement of the LED display, such as edge or chessboard artifacts, can be observed.

7.4.19 Spatiotemporal aliasing

The measurement steps are as follows:

- a) Project the resolution measurement signal;

- b) Check in the first row of seats, to see if the visible artifacts caused by pixel multiplexing or scanning of the LED display can be observed.

7.4.20 Jitter

The measurement steps are as follows:

- a) Project the black field measurement signal;
- b) Check in the first row of seats, to see if the pixel jitter of the LED display can be observed.

7.4.21 Pixel defects

The measurement steps are as follows:

- a) Project resolution, white, black, red, green, blue field measurement signals;
- b) Check in the first row of seats, to see if the LED display screen has pixel defects such as dead light, color loss, color blocks, bright spots, dark spots, bright lines, dark lines, seams, horizontal and vertical pixel misalignment, etc.

7.4.22 Frame rate

The measurement steps are as follows:

- a) Project frame rate measurement signals;
- b) Check if the digital movie LED projection system can play normally.

7.4.23 Reverberation time (RT_{60})

The measurement shall be carried out in accordance with the measurement steps specified in 5.3.9 of GY/T 311-2017.

7.4.24 Reverberation time frequency characteristics

The measurement shall be carried out in accordance with the measurement steps specified in 5.3.9 of GY/T 311-2017.

7.4.25 Background noise

It shall be measured according to the measurement steps specified in 5.3.10 of GY/T 311-2017.

7.4.26 Sound insulation

It shall be measured according to the measurement steps specified in 5.3.11 of GY/T 311-2017.

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