Applications of LED Displays in High-Definition Studios (Postprint)

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Abstract

In recent years, with the continuous advancement of China' s scientific and technological capabilities, various sectors of society have been developing at an accelerating pace. At present, the application of LED displays in high-definition studios has become increasingly widespread, emerging as a significant direction for television program development. In the practical application of LED displays, to achieve the desired presentation effects, it is imperative to formulate tailored LED display application solutions based on specific program types and broadcasting requirements, including connection methods, equipment types, and other relevant factors. Therefore, this paper analyzes and discusses the application of LED displays in high-definition studios, with the aim of providing references for enhancing the application level of LED displays in high-definition studios in the future.

Full Text

Application of LED Displays in High-Definition Studios

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Abstract

In recent years, with the continuous advancement of technology in China, various industries have experienced accelerated development. LED displays have become increasingly prevalent in high-definition studios and represent a significant direction for television program development. To achieve desired presentation effects in practical applications, it is essential to develop tailored LED display deployment strategies based on specific program types and broadcasting requirements, including connection methods and equipment selection. This paper analyzes and discusses the application of LED displays in high-definition

studios, aiming to provide references for enhancing their future implementation in broadcast environments.

Keywords: LED display; studio; high-definition; scenario; module pixel pitch; video processing

1. Development and Application of LED Displays

Compared to traditional television program display equipment, LED displays offer advantages such as rich color reproduction and convenient operation, allowing flexible adjustment according to program type and broadcasting needs. As the media industry has evolved, television program formats have become increasingly diverse, demanding higher presentation quality. Consequently, LED displays have gained widespread adoption in broadcasting. However, extensive application has also revealed notable issues, including severe "visual pollution" and inaccurate color reproduction for cameras. Therefore, industry practitioners must further improve LED display application standards, effectively manage the relationship between LED displays and cameras, and fully leverage their potential in television presentation.

Currently, LED display applications offer two primary advantages. First, they support multiple media formats, including video and images, and can implement split-screen functionality based on program broadcasting requirements. Second, LED displays exhibit strong virtuality and flexibility, serving not only as media display devices but also as lighting equipment. Many large-scale high-definition studios now use LED displays as scenic elements to present program content, such as background screens, circular scrolling displays, and ceiling screens. Meanwhile, smaller studios are installing LED screens at various angles to showcase multimedia materials from multiple perspectives. LED displays have become a mainstream trend in high-definition studios and will continue to gain popularity.

China first introduced LED displays into high-definition studios in 2002, when China Central Television's Spring Festival Gala utilized a 15 m^2 P10 single-lamp full-color LED screen. Since then, every Spring Festival Gala and major event has incorporated LED displays. With deepening application, display areas have grown larger, varieties have multiplied, and connection methods have diversified.

2.1 Working Principle of LED Displays

LED stands for Light Emitting Diode, which primarily consists of a P-N junction structure. When electrons in the P-N junction combine with holes, they transition from a high to low energy state, releasing energy and producing light emission. The color of LED light is determined by the elements contained in its material: GaAs emits red light, GaP emits green light, and GaN emits blue light.

LED displays comprise pixels that emit different colors. Color chips are pack-

aged in various ways to achieve different display functions. The smallest unit of an LED display is the pixel, with multiple pixels forming display modules. These modules, combined with different circuits and mounting structures, create display panels. Panels integrated with chassis, fans, power supplies, and other components constitute complete LED displays.

In principle, LED display illumination relies on electrons in the P-N junction transitioning from high to low energy states and releasing energy. Different materials determine the emission color. Based on specific requirements, pixels of different colors are arranged to achieve display functionality. Unlike other display devices, LED displays feature strong modularity, requiring multiple cabinet splicing in practical use. Therefore, different splicing methods directly affect display quality. Generally, smaller seams between cabinets yield better display effects.

2.2 Classification of LED Displays

From a system composition perspective, LED displays consist of software and hardware systems. The hardware system primarily includes chassis, power supply equipment, fans, monitors, and computers. Equipment selection must consider multiple factors, including electrical safety, maintenance difficulty, signal stability, and television program quality requirements. Additionally, modern LED displays feature highly compatible input signals.

LED displays can be categorized by usage environment into outdoor, indoor, and semi-outdoor types; by color into monochrome, dual-primary-color, and tri-primary-color displays; and by pixel density into various types such as P2, P6, and P10. Based on packaging methods, LED display chips are encapsulated with insulating plastic or ceramic materials to isolate them from the environment, preventing impurity corrosion of chip circuits and electrical performance degradation. Different packaging technologies produce various methods, with commonly used approaches including DIP, SMD, COB, SIP, and three-in-one packaging.

3. Application Strategies for LED Displays in Different Scenarios

Current application scenarios for LED displays in television station high-definition studios primarily include speech contests, variety shows, quiz competitions, and award ceremonies. Different usage contexts require distinct application strategies. This section analyzes these common scenarios to provide references for improving LED display implementation in high-definition studios. All external signal sources in these examples are converted through BARCO Image PRO before entering the system or being output to LED displays. The LED display control consoles use Jiesichuang LVP3000 or LVP2000 (without HD/SD SDI interface output) as practical examples, both featuring multiple VGA and DVI inputs, plus fiber optic or network ports via DVI conversion for connecting remote LED displays. Other display control consoles operate

similarly.

3.1 Application in Speech Contest Programs This scenario typically requires meeting contestants' needs for external computer projection. Therefore, control consoles can be installed near the LED display or lectern, operated either by contestants themselves or by dedicated staff during competitions. Equipment preparation should include sufficiently long DVI cables to accommodate connections across various distances. DVI cables primarily serve computers on stage, while VGA or HDMI cables are used for computers off stage. During connection, signals from both on-stage and off-stage computers are input into Image PRO, then looped out to the LED display control console. The SDI output from Image PRO connects to monitors to accurately track signal connection status, enabling rapid error location and improved connection efficiency. Separate computers are used for signal input when playing opening and closing VCRs, which are input into another Image PRO unit. In this scenario, the LED displays on stage and in the audience area use the same signal source but employ different connection methods, as shown in [Figure 1: see original paper].

3.2 Application in Variety Shows Unlike speech contests, variety shows utilize different signal sources for on-stage and audience area LED displays. On-stage displays typically show background animations and VCRs, while audience displays provide cue information for production teams without requiring director switching. Therefore, during variety show recording, on-stage LED displays supplement the program by playing corresponding visuals according to content and style. LED display control operators can play animations following the program flow. The purpose of audience displays is to assist on-site hosts. The specific wiring connection is shown in [Figure 2: see original paper].

3.3 Application in Quiz Competition Programs LED display application in quiz competitions is characterized by showing questions and answers to contestants, requiring flexible switching capabilities. During wiring, two video sources are connected to the LED display system via converters, with operators switching display content according to the actual program flow. In quiz competitions, on-stage and audience LED screens show identical content. It is important to note that HDMI signals directly converted from many devices default to 60p, which switching equipment often cannot recognize. Therefore, converters must be used to uniformly transform signals into SDI format before use. The specific connection method is shown in [Figure 3: see original paper].

3.4 Application in News Programs LED display application in news programs generally falls into two categories: using LED displays as backgrounds or for content display. When used as backgrounds, they typically display simple video and image materials, with computer content converted through Image PRO and transmitted to LED displays. For displaying news content, direct

connection can be made via switcher auxiliary output to the display system or through computer DVI interfaces, as shown in [Figure 4: see original paper].

4. Key Technical Considerations

4.1 Selection of Module Pixel Pitch Taking module pixel pitch selection in stage design as an example, LED displays are functionally divided into background screens and content screens, each composed of multiple panels. Background screens are typically farther from hosts and cameras, making moiré patterns virtually non-existent in practical use. Therefore, larger pixel pitch modules can be selected to reduce costs while ensuring display quality. Content screens, however, are closer to cameras and must display detailed content, requiring smaller pixel pitch for clarity.

4.2 Heat Dissipation Issues and Solutions LED display module heating is a common issue. Most heat dissipation designs utilize front ventilation. Therefore, during thermal management, air conditioning outlets should be positioned above the front panel of modules to enhance heat dissipation capacity and ensure stable system operation.

4.3 Screen Receiver Card Wiring Issues and Solutions In practical LED usage, when LED module sizes are small, screen receiver card wiring configuration must be addressed during on-site debugging. After completing LED display wiring, computer equipment is connected to the sending card end, and screen control software is used to configure receiver cards, as shown in [Figure 5: see original paper].

In the configuration interface, the receiver card wiring diagram has four lines representing four network cables carried by the receiver card, with S indicating the starting point and arrows showing wiring direction. After completing the wiring diagram, it is sent to hardware and data is transmitted to receiver cards for normal LED display operation. It is crucial to save data to receiver cards promptly after normal display is achieved.

4.4 Brightness Issues and Solutions During LED display operation, insufficient brightness causes unclear images, while excessive brightness increases studio operating costs. Therefore, LED display brightness must be adjusted according to actual studio conditions to ensure optimal clarity while controlling operating costs.

5. Common Problems and Troubleshooting

5.1 LED Display Abnormalities LED display abnormalities mainly include the following aspects:

(1) Black screen in control software mode, unable to display signal source. For this issue, operators should check display connections. If connections are normal, software signal output should be inspected.

(2) Black screen in single sending card mode. If the sending card green light is flashing, check display power supply and network cable connections. If the green light is not flashing, inspect DVI connections.

(3) Incomplete display or abnormal color display. For this problem, maintenance personnel can further identify causes based on display anomalies, including network cable issues, receiver card problems, or module defects.

(4) Unable to assign display. For this issue, maintenance personnel should verify and resend screen connection files, reconfigure sending cards using screen control software, and store configuration data.

5.2 Video Processor Control Software Issues Video processor control software problems mainly include:

(1) LED display image distortion. This issue primarily results from incorrect video output software resolution settings, requiring resolution configuration checks.

(2) LED large screen showing video processor software control interface. This occurs due to incorrect output screen selection in video processor control software and can be resolved by restoring correct selection in video output software.

Conclusion

With continuous development and improvement of LED display technology, its application in the television media industry has become increasingly widespread. Compared to traditional display equipment, LED displays in high-definition studios not only enrich display content and enhance clarity but also reduce studio operation difficulty and further improve television program production quality. However, practical application in high-definition studios still reveals numerous defects and shortcomings. Although LED display technology is self-emissive, its luminous effect is influenced by material properties and performance characteristics. Furthermore, different usage scenarios impose varying requirements on LED displays, necessitating customized approaches to wiring connections and module selection based on specific application contexts and needs. Only by mastering scientifically sound equipment selection schemes and application strategies can the role of LED displays in high-definition studios be fully realized, thereby enhancing television program presentation effects and quality, and laying a solid foundation for sustainable development of television media. Particularly with China' s continuously advancing technology, LED display types have become increasingly diverse. During equipment selection, decisions should be based on both practical application experience in high-definition studios and

comprehensive consideration of television program characteristics and studio operating cost control.

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Author Biography

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Note: Figure translations are in progress. See original paper for figures.