An Overview of the Technical Characteristics and Development Trends of Digital Television Transmitters: Postprint

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Abstract

With the continuous advancement of network technology and the ongoing development of economy and society, digital television transmitters have gradually evolved, progressively replacing conventional analog signal transmitters. This transition has resulted in cost savings, enhanced signal stability, improved picture clarity, and increased quality and efficiency of broadcast television transmission. Concurrently, to better satisfy the demands of industry development and user experience, transmitter technology necessitates further optimization and improvement. This paper examines the current issues facing digital television transmitters and investigates their future development trends through an introduction to the main components and technical characteristics of digital television transmitters.

Full Text

Preamble

Title: A Brief Discussion on Technical Characteristics and Development Trends of Digital TV Transmitters

Abstract: With the continuous advancement of network technology and the development of economy and society, digital TV transmitters have gradually evolved and replaced traditional analog signal transmitters. Compared with their predecessors, they reduce costs while providing more stable signals, clearer picture quality, and improved quality and efficiency of radio and television transmission. Meanwhile, to better meet the needs of industry development and user experience, transmitter technology must be further optimized and improved. This paper introduces the main components and technical characteristics of digital TV transmitters, analyzes existing problems at the current stage, and explores future development trends.

Keywords: digital television; transmitter; technical characteristics; development trends

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Due to its better user experience, clearer picture quality, richer content, and capabilities for multimedia interactivity, digital television has been rapidly accepted by the masses, driving the development of digital TV and prompting continuous improvement and optimization of transmitter technology to provide better audio-visual services and meet industry development needs. Therefore, research on the technical characteristics and development trends of digital TV transmitters in China is essential.

Correction circuits provide significant performance improvements for Class AB power amplifier transmitters [1]. Digital pre-correction technology also demonstrates strong adaptability to complex and variable environments, further enhancing transmitter efficiency and quality while ensuring high-quality digital images. Moreover, it can monitor aging and fault issues in digital TV transmitters as they age.

1. Core Components of Digital TV Transmitters

1.1 Exciter—The Core Component

The primary function of digital TV transmitters is to transmit digital signals. As one of the core components, the exciter plays a crucial role in this function, handling tasks such as audio and video encoding and digital pre-correction.

Specifically, in DVB-T systems, MPEG-2 primarily performs encoding and compression of video signals, enhancing picture clarity, while MUSICAM handles audio signal encoding and compression, reducing environmental noise and providing a better audio-visual experience. In ATSC systems, the MPEG-2 standard is used for video source coding, and Dolby AC-3 surround sound encoding is employed for audio. For digital TV transmitters, digital pre-correction technology can largely automatically adjust transmitter performance without excessive manual intervention, thereby improving efficiency. This is particularly true for high-performance intermediate-frequency nonlinear pre-correction.

1.2 Power Amplifier—Ensuring Stable Data Transmission

The power amplifier determines the output capability during signal transmission and is indispensable in digital TV transmitters. It amplifies relevant data

to enable broader transmission range and better results, providing audiences with an improved experience and meeting diverse needs. The power amplifier module in digital TV transmitters includes input level monitoring, pre-driver stages, driver stages, and final output stages [2]. Power amplifiers employ Laterally Diffused Metal Oxide Semiconductor (LDMOS) technology, which offers clear advantages over traditional bipolar transistors. LDMOS improves effective transmission efficiency without damaging equipment, enabling PA modules to achieve transmission effects of approximately 60 dB with gains exceeding 14 dB. Even when experiencing high power periods, they can withstand over-excitation signals. Using power amplifiers ensures more stable data transmission and prevents faults that could affect normal user operation.

1.3 Cooling System—Improving the Operating Environment

Digital TV transmitters continuously generate heat during operation. Without timely temperature reduction, internal components may be damaged, causing failures. Therefore, installing cooling systems is essential for ensuring normal transmitter operation. Currently, two main cooling systems exist in the market: air-cooled systems that dissipate heat through airflow, and liquid-cooled systems that circulate coolant through heat pipes. Although both are commonly used, air-cooled systems suffer from high noise levels, require dedicated fan rooms, create dirty operating environments, easily accumulate dust, cause damage to internal components, and are difficult to maintain. Consequently, most applications favor liquid-cooled systems. Compared with air-cooled systems, liquid-cooled systems operate with less noise, require no dedicated fan rooms (saving floor space), provide better cooling effects through their internal coolant, offer better sealing, reduce daily maintenance workload, ensure stable data transmission, deliver higher cooling efficiency, improve the operating environment of digital TV transmitters, and significantly enhance work efficiency.

2. Technical Characteristics of Digital TV Transmitters

2.1 High Reliability of Transmission Channels

Constructing digital TV transmitter transmission channels requires coordinated operation of multiple systems, including information source processing, power amplification, power supply, control, and cooling systems [3]. First, the information source processing system converts television audio and images from analog to digital information using digital encoding technology. This digital information undergoes correction and transmission, then converts from low to intermediate and high frequencies through carrier frequency conversion. Subsequently, the power amplification system boosts transmission power to deliver information to millions of households. Viewers receive digital signals through set-top boxes, ultimately presenting rich and varied television programs. Although some data distortion during transmission is inevitable, digital transmitters require significantly less correction than previous analog transmitters, producing more realistic images with higher operational efficiency and quality.

Additionally, digital TV transmitters utilize “redundancy” design by establishing independent power switches in each functional module, improving overall performance and ensuring greater safety and stability.

2.2 High Degree of Intelligence and Automation

With continuous improvement in socio-economic development levels and advances in electronic communication and network information processing technologies, digital transmitters have gradually entered an era of intelligent and automated development. Specifically, monitoring and intelligent system diagnostics can detect internal transmitter faults, saving time and money on manual maintenance. Through intelligent system control, fault locations can be quickly identified, allowing technical maintenance personnel to resolve issues in minimal time and maintain normal transmitter operation.

2.3 Strong Anti-interference Performance, High Transmission Quality, and Good Coverage Efficiency

Digital transmitters operating in decimeter wave bands demonstrate stronger anti-interference performance compared to analog transmitters operating in meter wave bands. Natural environmental electrical interference has minimal impact on transmitters, resulting in more stable signals and higher quality audio and video transmission. Lower user terminal reception thresholds significantly improve viewing effects, while signal coverage areas are substantially expanded. Traditional analog transmitters could only deliver one television program per channel, whereas digital television expands this capacity approximately tenfold, enabling more than ten programs per channel and greatly increasing the economic and social benefits of the radio and television industry.

3. Standards and Main Types of Digital TV Transmitters

3.1 Digital TV Transmitter Standards

Internationally, three major digital television standards have emerged: the American ATSC standard, the European DVB-T standard, and the Japanese ISDB-T standard. ATSC primarily employs single-carrier 8VSB encoding and modulation technology, while DVB-T and ISDB-T mainly utilize multi-carrier COFDM encoding and modulation technology. All three standards adopt the MPEG-2 standard for important video source coding, differing primarily in audio source coding: the United States uses AC-3, Europe uses MPEG-2, and Japan uses AAC.

3.2 Main Types of Digital Transmitters

Both domestically and internationally, the main transmitter types include Inductive Output Tube (IOT) transmitters, tetrode single-electron tube or bidirectional tetrode transmitters, and all-solid-state transmitters—all operating in

the UHF band. IOT transmitters are the preferred choice for high-power digital television applications and maintain strong competitiveness. Meanwhile, medium-power all-solid-state transmitters are also competitive and continue to develop. In recent years, with continuous scientific and technological advancement and innovation, domestic research has been exploring digital transmitters with greater variety and more comprehensive functionality.

4. Development Trends and Future Directions

4.1 Need for Further Technical Breakthroughs and Optimization

Compared with foreign technology, China's digital television technology still has many shortcomings. Digital transmitters have been in use nationwide for a relatively short time and remain technologically deficient, while foreign technology is more mature after long-term development. Consequently, most provincial-level and above media still employ foreign digital transmitters, presenting both greater opportunities and challenges for China's radio and television industry. This situation demands continuous research and development of new technologies to create digital TV transmitters with Chinese characteristics that suit national conditions, accelerating the R&D speed and technical standards of domestically produced transmitters. Only then can domestically manufactured equipment capture a larger share of the domestic market and promote national prosperity; otherwise, the domestic market will be monopolized by foreign products.

4.2 Domestic Industry Development Direction and Application Scope

Currently, China can already conduct live television broadcasts via satellite, improving information dissemination speed and coverage area. Integration with network terminals enables people to watch television programs on mobile phones. Domestically, efforts are now underway to combine mobile terminals with digital technology to develop a new generation of mobile television, with expectations of comprehensive coverage in public platforms such as subways, buses, and trains, allowing people to watch programs anytime and anywhere. As mobile television continues to develop, it can expand business scope, optimize industrial structure, and further promote the development of the radio and television industry.

Conclusion

As people's living standards continue to improve, demands on digital TV transmitters become more complex. Coupled with the continuous development of network digital technology, digital TV transmitter technology will inevitably enter new R&D fields, introducing more powerful and higher-quality digital TV transmitters to the market, further driving the development of the radio and television industry and achieving coordinated economic and social benefits.

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