Development and Maintenance of Digital Television Transmission Technology Postprint

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Abstract

With the continuous advancement of science and technology, numerous new technologies and processes have been extensively applied and promoted in cable digital television networks. While television viewing quality is further improved, this simultaneously imposes higher requirements on the design and maintenance of cable digital television networks. To effectively conduct cable digital television maintenance, it is essential to fully comprehend the composition of cable digital television systems and comprehensively analyze their design key points, thereby facilitating effective debugging and maintenance operations and elevating the development level of cable digital television.

Full Text

Preamble

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Abstract: With continuous advancements in science and technology, numerous new technologies and processes have been widely applied and promoted in cable digital television networks. While television reception quality has significantly improved, higher demands have been placed on the design and maintenance of cable digital television networks. To effectively maintain cable digital television systems, one must fully understand their composition and comprehensively analyze key design points to ensure proper debugging and maintenance, thereby enhancing the overall development level of cable digital television.

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1. Composition of Cable Digital Television Systems

Cable digital television systems deliver digital television services through cable networks. While various configurations exist based on functional design requirements, the system primarily consists of three core components: the headend, transmission network, and user terminals. Digital television signals are transmitted to end users via HFC (Hybrid Fiber-Coaxial) networks, which currently employ ring-star-tree topology structures with a single headend. In cable digital television systems, the headend serves as the core, the transmission network forms the foundational platform, and the user terminals reflect the final operational outcomes. System implementation requires installing digital television hardware and software at the existing cable network headend, along with a digital set-top box at each user terminal.

2. Characteristics of Digital Television Transmission Technology

Digital television signals exhibit higher transmission reliability because they undergo multiple sampling, quantization, and encoding processes. Even when subjected to external noise interference during transmission, error-coding technology can promptly correct disturbances within the rated controllable range. Digital television equipment facilitates convenient signal storage without strict requirements for signal intensity or timing. To better meet diverse user demands in the future, it is essential to master digital television signal transmission technology and pursue continuous improvements.

3. Key Points of Digital Television Network Transmission Design

3.1 Advantages of Digital Television Networks

Digitization represents the inevitable evolution of cable television. China's radio and television digitization is now fully underway, with broadcasting bureaus at all county and city levels operating their own HFC cable television networks. These networks, combined with optical fiber trunks, microwave trunks, and satellite routes, have formed a massive nationwide broadcasting network with several key advantages.

First, compared with traditional cable television systems, bidirectional transmission capability is far more important in cable digital television systems. Before digitization, analog signal transmission was primarily unidirectional, with

users passively receiving signals at their terminals. With information technology development, digital signal transmission systems enable active interaction, allowing users to request on-demand services from cable operators and fully demonstrating the multimedia capabilities of cable digital television.

Second, digital signal transmission can support six to eight times more channels than analog signal transmission within the same bandwidth. For instance, bandwidth capable of transmitting 50 analog channels can accommodate 350 digital channels. Calculating cable losses based on 750MHz transmission bandwidth aligns with future cable digital television system requirements.

3.2 Digital Television Network Transmission Design

Two primary transmission methods currently exist in cable digital television: SDH network transmission and cable digital television carrier transmission. An SDH system channel can transmit 7 SDTV programs, while a 64QAM+ carrier transmission system uses QAM modulation to multiplex multiple digital television signals onto analog carriers for multi-channel transmission via frequency division multiplexing.

In HFC network digital television transmission, all technical indicators must strictly comply with international standards, particularly carrier-to-noise ratio (C/N), nonlinear indicators, and modulation error ratio (MER). With BER at 10E-8, transmission 干线 can be designed using three module options: three-split, four-split, and no-split configurations. User terminals connect via radial star-shaped centralized distribution, with one passive centralized splitter serving 8 to 16 user terminals. Each optical workstation accommodates approximately 500 users through 1-3 distribution modules across its four output ports.

User terminal socket levels should be calculated at 70$±$3dB. For system calculations at 20℃, the line attenuation constant can be considered as 750MHz, where every 100m of coaxial cable introduces 19.1dB attenuation. The distance between passive centralized splitters and user terminal sockets should be controlled within 30m, with transmission trunk cables and models selected based on transmission distance.

4. Debugging and Maintenance of Cable Digital Television Networks

4.1 Network Debugging

Network debugging constitutes the process of implementing system index allocation according to design specifications, primarily including headend QAM modulator debugging, optical link debugging, and user distribution network debugging.

First, for QAM modulator debugging, select appropriate modulation frequency points using the designed output frequency as the modulator's output frequency.

Digital television frequency points should use channel center frequencies rather than image carrier center frequencies. For example, when transmitting digital television programs on ZI channel (111-119MHz range), 115MHz should be selected as the frequency point. The primary modulation method is 64QAM, with a transmission symbol rate of 6875kb/s. The RF signal output level should be adjusted according to design requirements, with modulation error rate (MER) and bit error rate (BER) measured and recorded for all frequency points. Typically, MER should be maintained below 32dB, with all modulation data documented to facilitate future maintenance and acceptance.

Second, optical link debugging is essentially similar to analog systems, requiring the optical transmitter's RF input level to meet design specifications. After measuring the optical transmitter's output power, remeasure the optical power at the receiving point, compare these values with design specifications, adjust the optical receiver's output levels according to design requirements, and perform detailed measurements and recordings.

Third, user distribution network debugging is similar to analog system debugging. Amplifier input and output levels should be adjusted according to design specifications, with amplifier outputs configured as flat or tilted. Input levels must exceed the amplifier's minimum required input level, with all debugging data properly documented.

4.2 Network Maintenance

Compared with analog system maintenance, cable digital television system maintenance shares many similarities but differs in fault phenomena and handling approaches. Common terminal faults include inability to receive all programs, partial program reception failure, or mosaic effects. If all digital television programs are unavailable, first check whether the user can receive the reserved 6 analog programs. Successful analog reception indicates acceptable signal quality, suggesting the fault lies in the set-top box, television, or improper operation. Since analog and digital programs share the same cable transmission, network-related faults can generally be excluded.

If analog programs are also unavailable, the television is functioning properly, and the fault primarily results from network issues or improper user line connections. For network-related faults, maintenance personnel must conduct on-site troubleshooting by measuring RF levels and MER at user ports to identify causes through systematic, level-by-level elimination.

5. Conclusion

In summary, with China's rapid socio-economic development, information and network technologies have advanced swiftly. Cable digital television network technology has enriched our lives, and to promote its continued development, we must prioritize network design and maintenance as key factors for enhancing market competitiveness.

References

[1] Yang Zhongli. Analysis of Cable Digital Television Network Security Maintenance and Management[J]. Communication World, 2016(20).

[2] Tan Jingying. Reflections on Cable Digital Television Network Maintenance[J]. Communication World, 2016(21).

[3] Wang Shunquan, Yang Guohua. Analysis and Discussion on Cable Digital Television Network Security Maintenance and Management[J]. Network Security Technology and Application, 2016(06).

[4] Zhang Juan. Technical Maintenance of Cable Digital Television Networks[J]. Friend of Science, 2017(12).

[5] Zhang Wenjian. Fault Diagnosis and Repair Methods for Cable Digital Television Systems[J]. Digital Users, 2016(12).

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