

Characteristics and Daily Maintenance Experience of Radio and Television Transmitters - Post-print

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Abstract

Broadcast television transmitters are devices that transmit electromagnetic signals to television receivers. Television transmitters may be analog or digital; the discussion primarily focuses on the principles of analog systems, as they are typically more complex than digital transmitters due to the multiplexing of VSB and FM modulation stages. Transmitters are generally limited to devices that generate radio waves for communication purposes. During the operation of broadcast television transmitters, numerous faults may arise due to interference from external factors; therefore, corresponding routine maintenance measures must be implemented to ensure the transmitter remains in normal operating condition, thereby guaranteeing the smooth broadcast of radio and television programs.

Full Text

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Abstract: Broadcast television transmitters are devices that transmit electromagnetic signals to television receivers. These transmitters may be analog or digital, though the principles are generally summarized based on analog systems because they are typically more complex than digital transmitters due to the multiplexing of VSB and FM modulation stages. Transmitters are generally limited to devices that generate radio waves for communication purposes. During operation, broadcast television transmitters may experience numerous faults due to external interference. Therefore, corresponding daily maintenance measures must be implemented to ensure the transmitter remains in normal operating condition, thereby guaranteeing smooth broadcast of television programs.

Keywords: broadcast television; transmitter; characteristics; common faults; maintenance strategies

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Historical Development

In 1887, German physicist Heinrich Rudolf Hertz built the first primitive radio transmitters during his pioneering research on radio waves, which generated radio waves through high-voltage electric sparks between two conductors. The invention of transistors enabled the development of small portable transmitters in the 1960s. In recent years, the need to conserve crowded radio spectrum bandwidth has driven the development of new types of transmitters, such as spread spectrum and cognitive radio technologies.

1. Characteristics of Broadcast Television Transmitters

Broadcast television transmitters consist of relatively numerous components. These include a power supply circuit that converts input electricity into the higher voltages required to produce the desired power output. An electronic oscillator circuit generates the RF signal, producing a constant-amplitude sine wave commonly referred to as the carrier wave. Since it is used to transmit information “through space,” this is typically a crystal oscillator in most modern transmitters, with its frequency precisely controlled by quartz crystal vibrations. A modulator circuit adds the information to be transmitted to the carrier wave generated by the oscillator, accomplished by altering certain aspects of the carrier. The information is provided to the transmitter in the form of audio signals representing sound, video signals representing moving images, or binary digital signals. An RF amplifier increases the signal’s power to extend the range of the radio waves. An impedance matching circuit matches the transmitter’s impedance to the antenna’s impedance, thereby efficiently transferring power to the antenna. If these impedances are not equal, a condition called standing waves occurs, where power is reflected from the antenna back to the transmitter, wasting power and sometimes causing the transmitter to overheat.

The most distinctive feature of broadcast television transmitters is their modular design. Operating in a parallel amplification state, they employ multiple transistor power amplifier modules in a combined amplification configuration. With multiple transistors working simultaneously, broadcast interruptions can be avoided when faults occur—if one transistor fails, the others can continue to bear the operational load. This power synthesis approach can significantly enhance the transmitter’s output power capability and stabilize its operating condition.

Broadcast television transmitters have adopted long-life semiconductor devices to replace limited-life electron tube components, saving the costs of regular electron tube replacement and substantially improving operational stability. New-generation broadcast television transmitters all employ intelligent management systems, typically featuring unmanned, remotely controllable designs. Technicians can continuously monitor the transmitter's operating status via computer, assessing its working condition through changes in operational parameters. When faults occur, they can also issue computer commands to promptly eliminate non-serious issues, saving considerable troubleshooting time while providing reliable basis for scientific fault resolution.

2. Daily Maintenance Measures

2.1 Maintaining Constant Temperature in the Equipment Room

The equipment room housing broadcast television transmitters has stringent temperature requirements. Both excessively high and low temperatures can affect normal transmitter operation. Overly high temperatures impact heat dissipation and may cause equipment shutdown in severe cases, adversely affecting program broadcasting. Therefore, it is essential to maintain a constant temperature environment in the equipment room, specifically controlling the temperature between 5-35°C.

2.2 Enhancing Voltage Stability

Strengthening the stability of the power supply voltage in the transmitter equipment room is fundamental to ensuring stable transmitter operation and the basis for calmly responding to various emergencies. Therefore, the capacity of the regulated power supply must be maintained at three times the transmitter's maximum power consumption to guarantee power supply voltage stability to the greatest extent.

2.3 Regular Cleaning

During long-term operation, broadcast television transmitters become contaminated by dust accumulation. As the most frequently used component, transmitters generate substantial heat during operation. Excessive dust buildup will impair heat dissipation functionality, leading to excessive oxidation of equipment and affecting normal transmitter operation. Dust problems primarily result from inadequate cleaning practices. Therefore, technicians must inform cleaning staff about transmitter cleaning precautions and regular cleaning schedules, ensuring they understand proper cleaning procedures and avoid damaging the transmitter during the process. Attention should be paid to using dehumidifiers to address humidity issues in the equipment room, ensuring that regular cleaning effectively enhances transmitter operational stability and safety.

2.4 Testing Various Equipment Indicators

In addition to regular cleaning for daily transmitter maintenance, emphasis should be placed on detecting equipment operating parameters through rigorous indicator comparison and analysis. By analyzing these parameters, technicians can determine whether the equipment is operating normally. Key parameters include antenna feed standing wave ratio, power supply voltage, actual operating power, etc., which significantly impact overall system operation. Therefore, assigning dedicated technical personnel to monitor and analyze these parameters enables more rapid detection of system operational faults. Technicians should conduct regular testing of various equipment indicators during daily maintenance work and document test results to provide reliable basis for fault diagnosis and resolution. Practical testing helps technicians continuously discover new maintenance methods and promptly eliminate transmitter faults, thereby promoting healthy development of the broadcast television industry.

3. Common Faults and Troubleshooting

3.1 Display Does Not Light Up After Power-On

After ensuring the transmitter is connected to the power cord, if the transmitter's display screen shows no response, the issue may be that the three-phase voltage is not in working condition. Technicians must immediately troubleshoot this problem and restore normal three-phase voltage status.

3.2 Increasing Transmit Power but Decreasing Output Power

Increasing transmit power accompanied by decreasing output power is a common fault. Technicians can employ different troubleshooting methods based on the specific situation. First, conduct a comprehensive inspection of the antenna feed system's operating status. If the antenna feed standing wave ratio is between 1.1 and 1.2, the antenna feed system is operating normally. Next, monitor and analyze the dynamic current of the transmitter's power amplifier tubes. If the current's dynamic operating trajectory fluctuates beyond the normal range, immediate replacement is required to restore normal transmitter power emission and output.

3.3 Sudden Current Increase During Power-On

If a sudden current increase occurs when powering on, technicians must first detect the overall circuit operating condition to determine whether component short circuits have occurred. Technicians can make reliable judgments through relevant values on the display screen to obtain accurate results, then systematically inspect switching power supplies to identify any that cannot enter normal working status, replacing non-functional power switches.

3.4 Power Amplifier Overheating Protection

When power amplifier overheating protection is triggered, technicians must check the air duct clearance to determine if blockage has occurred. Then, conduct a comprehensive inspection of the fan's working condition to verify normal operation; if not, promptly repair it. Next, detect the humidity environment where the fan operates, controlling it within a reasonable range to avoid adverse effects on fan operation. Finally, monitor the transmitter's operating temperature to determine whether overheating protection was triggered by excessive operating temperature. If so, necessary cooling measures should be taken to restore normal operating temperature.

3.5 Power Amplifier Overload Protection

When power amplifier overload protection occurs, technicians must first inspect the hardware equipment connection status to determine if it is in normal working mode. Then analyze whether the amplifier's output terminal is properly connected and check for loose transmission frequency plugs, ensuring coordinated operation and normal cooperation among all equipment components to fully realize the function and value of different machines.

3.6 Power Amplifier Excitation Protection

Power amplifiers are used frequently and thus experience relatively high failure rates. If excitation protection occurs during normal operation, technicians may need to comprehensively determine whether the machine's output power exceeds normal ranges, then identify whether improper operational behaviors caused the excitation protection to activate, making timely corrections to inappropriate actions.

3.7 Fan Unable to Operate Normally

Fans play a crucial role in maintaining equipment room temperature. Once a fan falls into non-operational status, it will affect the entire equipment room's operation. Therefore, after a fault occurs, technicians must promptly inspect the three-phase electrical connection status to determine if the correct connection method is used, making timely adjustments if necessary.

3.8 Automatic Power-On Function Failure

Modern broadcast television transmitters operate automatically, capable of powering on and off based on external operating conditions. When technicians discover that the transmitter cannot automatically power on normally, the automatic power-on function has definitely malfunctioned. Technicians must inspect the connection line sequence and determine whether the main unit has experienced crashes or similar issues, promptly restoring the transmitter's automatic power-on function.

3.9 Excessive Standing Wave Protection

The normal operating fluctuation range for antenna standing wave ratio is typically 1.1-1.5. If detection data shows abnormalities, technicians must inspect the antenna's integrity, the instrument's automatic switching function, the exciter's operational status, etc., then resolve identified issues to ensure the exciter fulfills its role and value during transmitter operation.

The main characteristics of broadcast television transmitters include relatively numerous components, modular design, adoption of long-life semiconductor devices, and implementation of intelligent management systems. Therefore, daily maintenance should focus on maintaining constant equipment room temperature, enhancing voltage stability, performing regular cleaning, and testing various equipment indicators. When transmitter faults occur, they must be addressed promptly to ensure normal operation of the entire system. Daily maintenance requires technicians to master equipment operation and maintenance manuals, continuously improving their understanding of transmitter knowledge to adopt effective maintenance methods and fault handling measures.

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