Analysis of Common Faults and Maintenance Measures for Medium Wave Transmitters (Post-print)

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Abstract

Due to their excellent stability and multiple powerful functions, medium-wave transmitters are widely utilized in the broadcast transmission industry. Therefore, the stability of medium-wave transmitters directly affects the operational performance of broadcast signal transmission equipment. This paper first analyzes the structure of medium-wave transmitters, thereby classifying potential faults that may occur during operation to facilitate their maintenance.

Full Text

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Abstract

Due to their excellent stability and powerful functionality, medium wave (MW) transmitters are widely employed in broadcast transmission applications. Consequently, the stability of MW transmitters directly impacts the performance of broadcast signal transmission equipment. This paper first analyzes the structure of MW transmitters to classify potential operational faults, thereby facilitating maintenance activities. By understanding fault mechanisms, technicians can better assess the likelihood of failures and implement more effective maintenance strategies for MW transmitters.

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MW transmitters consume less energy and operate with higher efficiency while accurately forwarding and propagating broadcast signals. However, during operation, various factors frequently cause malfunctions that adversely affect operational stability. Therefore, practical maintenance measures must be implemented based on analysis of common faults to ensure safe and stable MW transmitter operation.

1. Fault Classification of MW Transmitters

Soft faults in MW transmitters primarily result from improper operation during use. Hard faults occur randomly and accidentally, and can be further subdivided into sudden faults and complete faults. Sudden faults typically arise from abrupt changes in internal components during operation, whereas complete faults result from line damage due to aging or substandard quality within the transmitter. For example, sudden increases in resistance values of certain components, or open and short circuits within the transmitter, constitute hard faults.

2. Fault Patterns

As electronic equipment, MW transmitters exhibit predictable failure patterns despite the difficulty of forecasting specific faults. MW transmitter failures can be categorized into three distinct periods: initial, random, and wear-out. MW transmitters are complex devices for broadcasting radio waves. During the initial period, the transmitter maintains normal standby operation with minimal faults, typically lasting 6–12 months. During the random period, the transmitter continues stable operation with generally low failure rates and all parameters within standard ranges; occasional faults mostly stem from external causes, with this period lasting 8–15 years. During the wear-out period, failure rates increase with equipment age, though timely maintenance can sustain 3–5 additional years of normal operation. Understanding these patterns enables better maintenance planning for MW transmitters.

3.1 Transmitter Fails to Start Normally

Sudden over-current in MW transmitters can prevent normal startup and cause function board burnout during forced activation. When a transmitter fails to start, maintenance personnel must thoroughly inspect the main distribution board for arcing, overheating, or poor contact, performing maintenance or replacement of plugins as needed. Check whether resolver components have normal DC voltage, whether input signals are correct, and whether foreign objects are present in the power amplifier board, repairing issues promptly to prevent

over-current. Inspect and maintain the ring modulation encoding board to ensure proper component operation. If no specific faults are detected after checking each component, inspect the power supply to ensure the transmitter is not compromised by DC instability, loose sockets, or faulty pins.

3.2 Unstable Output Power During Operation

If the power synthesis motherboard fails, MW transmitter performance may become unstable when copper coaxial switches or antenna feed lines develop problems. For this fault type, first place the transmitter in standby test mode to determine whether the power synthesis motherboard is the cause, then repair or replace it. Alternatively, use a dummy load to verify normal transmitter operation. If the transmitter operates normally, the copper coaxial switch may be faulty; if the switch is not properly seated, repair it promptly. When the coaxial switch operates normally, inspect the connection between the antenna feed line's hard feeder tube and flexible feeder. Furthermore, to ensure optimal transmitter operation, routine maintenance and repair of antenna feed lines and antenna tuning networks must be performed.

3.3 Power Amplifier Module Damage

If power amplifier modules sustain repeated damage at the same location, the most probable cause is improper drain phase timing. During such faults, module temperatures rise rapidly, risking equipment damage. Visible arcing marks on module slots indicate fault occurrence, requiring immediate inspection of modules and encoding boards to locate and repair fault points. If damage occurs repeatedly at different positions on the same amplifier module, switching circuit faults, thermal insulation damage, or severe cold soldering on the module board are likely causes. Therefore, when inspecting switching circuits, verify circuit integrity and check for damaged module components. Additionally, inspect insulation between heat sinks and field-effect transistors, and examine other modules for soldering defects or heat sink burrs to identify and address cold soldering or bridging issues.

3.4 Under-Excitation Fault

Under-excitation faults occur when internal RF excitation signals are too low. If the monitor displays a red signal light without exciter issues, the circuit itself is likely faulty. Random module damage or buffer amplifier problems can also cause excitation faults. During maintenance, technicians must observe phase settings and understand compensation switch status. Inspect buffer amplifier internal components and socket contacts to identify and resolve issues promptly.

3.5 Buffer Amplifier Malfunction

Buffer amplifier faults can be identified through abnormal indicator light colors, requiring careful fault analysis. First, check buffer amplifier voltages, including primary, secondary, and tertiary RF amplifiers, to verify indicator operation. If indicators illuminate normally, check potentiometer operation. Maintenance typically involves replacing the buffer amplifier module; after restart, verify normal indicator operation to confirm proper transmitter function.

3.6 Transmitter Fails to Start Normally

Multiple causes can prevent MW transmitter startup, with oscillator failure being most probable. If the transmitter cannot receive external high-frequency signals, it cannot generate excitation signals, potentially causing transmission failure. When troubleshooting oscillator faults, first verify equipment presets. If all settings are correct, replace the digital frequency synthesizer exciter.

4.1 Optimizing Transmitter Operating Environment

MW transmitters are highly susceptible to environmental factors such as humidity, temperature, and dust, which adversely affect operation. Therefore, regular cleaning is essential to extend equipment life and ensure component flexibility and accuracy. Maintain clean equipment spaces with good air circulation. Install air filters before transmitter filter components and clean filter debris regularly to improve environmental cleanliness. When cleaning, regularly service environmentally sensitive components using specialized tools or vacuum cleaners to maintain internal cleanliness.

4.2 Timely Replacement of Components and Terminals

Regular component inspection prevents MW transmitter failures. Most current flows through components and terminals, generating thermal effects that significantly increase power dissipation at these points. Faulty components and wire terminals negatively impact system operation and may destroy entire assemblies. During routine maintenance, carefully inspect parts for damage, corrosion, or looseness. Additionally, examine internal circuits to ensure all wire terminals are secure. Regular component and terminal replacement reduces maintenance costs and ensures operational stability.

4.3 Regular Inspection of Transmitter Switchgear

Switch faults are common in MW transmitters. If equipment itself is functional but power switches fail to energize, blind component replacement without switch inspection wastes resources. Therefore, regular switchgear inspection is necessary. Verify proper operation, test sensitivity, and ensure switchgear provides maintenance personnel safety, as many devices operate at high voltage or current, posing significant safety risks if not regularly inspected.

4.4 Careful Inspection of Critical Voltage Waveforms

MW transmitter RF drive enables effective measurement of front-end DC and voltage fluctuations. During maintenance, verify data repeatedly to identify discrepancies between actual and original values, ensuring consistency. Meticulous examination and detailed recording of voltage waveforms are crucial for establishing reliable baselines for future inspection and repair work.

Conclusion

MW transmitters are core components of broadcast equipment. During operation, various factors cause frequent faults that affect normal signal transmission. Maintaining operational stability requires effective maintenance measures for common faults to ensure proper transmitter function and contribute to broadcast industry advancement.

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