# Analysis of Co-channel Interference in Medium-Wave Synchronized Broadcasting Networks: Postprint

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## Abstract

This paper presents a comprehensive analysis of co-channel interference problems in medium-wave synchronous broadcasting networks, proposes corresponding countermeasures, and describes the current application status of medium-wave synchronous broadcasting technology, aiming to provide favorable conditions for its development.

## Full Text

## Analysis of Co-channel Interference Issues in Medium-Wave Synchronous Broadcasting Networks

**Abstract:** This paper provides a comprehensive analysis of co-channel interference problems in medium-wave synchronous broadcasting networks, proposes corresponding solutions, and elaborates on the current application status of medium-wave synchronous broadcasting technology, aiming to create favorable conditions for the technological development of medium-wave synchronous broadcasting.

**Keywords:** medium-wave; synchronous broadcasting network; co-channel interference; problems; countermeasures
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### 1.1 Development History

Medium-wave synchronous broadcasting technology primarily utilizes medium- and low-power ground waves to achieve comprehensive coverage, thereby expanding its application scope. This approach not only extends broadcast signals to more users but also improves the utilization rate of medium-wave synchronous broadcasting technology. However, given China's vast territory, achieving complete nationwide coverage presents significant challenges. Some regions feature complex topography that complicates implementation, requiring engineers to maximize the use of transmitter ground waves to ensure audience reception. Nevertheless, China has limited medium-wave frequency resources, necessitating repeated use of ground wave frequencies during transmission. This frequency reuse causes co-channel interference among ground waves, affecting both the application of medium-wave synchronous broadcasting technology and audience listening quality. China began implementing medium-wave synchronous broadcasting technology in the 1960s, with development progressing more slowly compared to developed countries and related technologies remaining imperfect. Therefore, relevant authorities must strengthen their emphasis on medium-wave synchronous broadcasting technology and increase investment to provide favorable conditions for its advancement. In recent years, continuous development of information technology has gradually steered medium-wave synchronous broadcasting toward digitalization and intelligence, with Chinese applications beginning to incorporate internet technology, satellite technology, and other innovations that have promoted technological progress in this field.

### 1.2 Principles of Medium-Wave Synchronous Broadcasting

Medium-wave synchronous broadcasting networks can effectively unify multiple medium-wave stations and provide frequency source coverage without geographical limitations, enabling frequency coverage across different locations so that users in various regions can receive broadcast signals. The system primarily operates in two modes. First, the phase synchronization system, which uses a standard signal source to calibrate crystal oscillator frequencies, imposes specific requirements on frequency difference—the primary cause of periodic signal fading. This necessitates that engineers understand frequency difference characteristics to minimize its occurrence and fully leverage the advantages of medium-wave synchronous broadcasting technology. In medium-wave synchronous broadcasting networks, the synchronous protection ratio serves as the main factor in evaluating reception quality; only effective synchronous protection can prevent co-channel interference and enhance audience listening experiences. Second, the frequency synchronization system shares similar requirements with the phase synchronization system. Once engineers understand the phase synchronization requirements, they can master the relevant specifications of frequency synchronization, thereby improving the operational efficiency of medium-wave synchronous broadcasting networks.

### 2.1 Echo Interference Issues

Since 2016, Inner Mongolia's medium-wave programs have primarily adopted synchronous network transmission coverage. The increasing number of relay stations and transmission power has exacerbated medium-wave co-channel interference problems, with echo interference being the main cause. Echo interference arises from phase instability that creates phase delay, which in turn causes frequency-selective fading that affects listening quality. When time delay exceeds 250ms, listeners experience audible distortion that prevents clear reception of broadcast content. Investigations of medium-wave stations revealed that significant variations in receiver equipment types contribute to co-channel interference problems. Additionally, arbitrary signal source usage at medium-wave stations, with staff failing to follow prescribed procedures or notify each other during signal source switching, combined with poor staff quality and lack of collective awareness, creates phase delays that degrade listening quality.

### 2.2 Fading Issues

Fading interference represents one of the primary co-channel interference problems in medium-wave synchronous broadcasting networks. The main cause is carrier frequency difference—medium-wave synchronous broadcasting has stringent synchronization requirements, with frequency synchronization being fundamental. Only by ensuring ground waves operate at identical frequencies can the network function properly, and engineers must prevent carrier frequency difference to reduce co-channel interference. If the carrier frequency difference is less than 20Hz, listeners hear some noise; if it exceeds 20Hz, a beat phenomenon occurs. Therefore, engineers must minimize carrier frequency difference to ensure listening quality, requiring enhanced attention to carrier frequency difference control and implementation of preventive measures. Survey results indicate that some duty rooms lack air conditioning, with high indoor temperatures making equipment casings hot to the touch and affecting equipment lifespan. Furthermore, some staff fail to follow prescribed procedures for powering on and receiving standard frequency signals, still using manual frequency calibration methods. Low staff quality and problems during calibration processes increase fading issues.

## 3. Solutions for Co-channel Interference in Medium-Wave Synchronous Broadcasting Networks

To prevent co-channel interference in medium-wave synchronous broadcasting networks, relevant personnel must strengthen their emphasis on the technology and promote its widespread application in broadcast transmission centers.

First, standardize all medium-wave stations. Since Inner Mongolia has numerous medium-wave stations, engineers must unify equipment and model specifications to ensure consistency and prevent co-channel interference that affects listening quality. As stations have significant differences in software versions that can cause time delays, signal combiners should be integrated while ensuring signal quality. Relevant departments must increase equipment funding to ensure safety and prevent security risks from outdated equipment at broadcast transmission centers. Additionally, staff should conduct regular equipment inspections to ensure normal operation, with immediate repairs by technicians once potential hazards are identified to avoid co-channel interference.

Second, ensure proper operation of frequency crystals in synchronous exciters. This requires staff to follow prescribed procedures, effectively control crystal temperature to prevent adverse effects from excessive temperatures, and reduce maintenance costs. Staff must also perform regular exciter maintenance, strictly execute frequency calibration procedures, and effectively control carrier frequency difference. Relevant departments should enhance staff training to help them recognize the importance of their work and fully commit to frequency calibration tasks to meet prescribed standards. Furthermore, staff should regularly update relevant software and strictly control carrier frequency difference values to provide a favorable operating environment. Air conditioning should be installed in rooms containing critical equipment to maintain appropriate temperatures for frequency crystal operation.

Finally, ensure 24-hour operation of medium-wave station synchronous systems. Staff must conduct real-time monitoring of medium-wave stations to effectively receive standard frequency signals, requiring them to understand synchronous systems and perform automatic frequency calibration. This not only reduces staff workload but also improves work efficiency. Relevant departments must also strengthen technical management, increase staff training to help them recognize their work importance, ensure strict adherence to prescribed procedures, and prevent arbitrary signal source changes that significantly impact equipment. Additionally, coordination among medium-wave stations must be enhanced. Due to the large number of stations, arbitrary signal source changes can easily cause co-channel interference, necessitating effective coordination work where various departments coordinate effectively during signal source changes to improve listening quality.

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