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Construction of N+1 Backup System for FM Broadcast Transmitters: Postprint

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Abstract

This paper describes the construction of a backup system for multiple frequency transmitters utilizing a multiplexer, coaxial switches, and a wideband backup transmitter, wherein a single transmitter serves as backup for multiple units. The system advantages include prevention of harmonic generation that interferes with civil aviation communications, low capital investment, and minimal equipment room space occupation. Compared with a one-to-one backup system, its disadvantage is the requirement for manual frequency adjustment of the backup transmitter before switching.

Full Text

Construction of an N+1 Backup System for FM Broadcast Transmitters

Abstract: This paper describes the construction of a backup system that uses a single transmitter to backup multiple frequency transmitters through the integration of a multiplexer, coaxial switches, and a broadband backup transmitter. The primary advantages of this system are its ability to prevent harmonic interference with civil aviation communications, its low capital investment, and its minimal occupation of equipment room space. Compared to a one-main-one-backup system, its disadvantage is the requirement for manual frequency adjustment of the backup transmitter before switching.

Keywords: broadband backup transmitter; multiplexer; coaxial switch

1.1 FM Transmitting Antenna

FM transmitting antennas must utilize broadband designs. At all transmitted frequencies, the voltage standing wave ratio (VSWR) should be ≤ 1.1 dB, and

the antenna's power rating must exceed the sum of all transmitter output powers with sufficient margin. The preferred configuration is a multi-layer, double-dipole antenna with reflector panels on four sides; however, multi-layer single-dipole vertically polarized antennas may be used when tower space is limited. The Tongliao station employs a four-sided, six-layer double-dipole horizontally polarized antenna with reflector panels.

Feedlines typically use SDY-50-80 type coaxial cable with a VSWR generally within 1.05 dB. Excessive length redundancy should be avoided, with feedlines routed directly above the multiplexer upon entering the equipment room to minimize the length of 80-mm rigid feedline and reduce the number of connectors and elbows. The antenna-end connector must match the antenna output interface, while the equipment room end typically uses a 31/8 flange interface.

1.3 Multiplexer

Multiplexers are generally categorized into star-point and bridge types. Star-point multiplexers feature simple construction with >30 dB inter-frequency isolation but require frequency spacing greater than 4 MHz and are prone to heat generation. Bridge multiplexers are more expensive, provide >40 dB isolation, and only require frequency spacing greater than 1.2 MHz.

1.4 FM Transmitter

Each main transmitter may use a fixed-frequency unit, while the backup transmitter must be broadband-capable. The backup transmitter's exciter should be a full-band unit with convenient operation, adjustable power, and adjustable frequency.

1.5 Coaxial Switch

RF coaxial switches are evaluated by four parameters: isolation, insertion loss, power handling, and switching time. For this application, isolation must be ≥ 60 dB, insertion loss < 0.1 dB, and power rating must exceed the transmitter output power; switching time is less critical. Interfaces typically use 13/8" direct feed connections for compatibility with 40-mm rigid feedline connections between transmitters and multiplexers. Coaxial switches offer manual, electric (local), and remote control options through a switch controller.

1.6 Signal Source Switcher

Each transmitter's signal source can be delivered through a matrix or patch panel, enabling selection of the backup transmitter's signal source.

2. System Equipment Connection

Constructing an FM broadcast transmitter N+1 backup system requires N coaxial switches and one dummy load, connected as shown in Figure 1 [Figure 1:

see original paper]. The coaxial switches must meet transmitter power requirements and feature both manual switching and electric push-button control. The dummy load must also satisfy transmitter power requirements, allowing each transmitter to be switched to the dummy load for maintenance and debugging. The backup transmitter can be switched via coaxial switches to replace any corresponding main transmitter.

3.1 Equipment Placement

The backup transmitter and dummy load should be positioned on either side of the main transmitters. Main transmitters should be arranged sequentially by frequency according to the multiplexer output port positions, avoiding rigid feedline crossings that would compromise installation aesthetics.

3.2 Rigid Feedline Connection Requirements

The number of connectors and elbows, along with connection workmanship, directly affects system insertion loss and can severely impact transmitter power output, potentially causing excessive VSWR protection. Rigid feedlines must be cut with a pipe cutter, not a hacksaw, with edges properly dressed after cutting. Connections require proper core insertion depth and secure contact, with clamps fully tightened.

3.3 Differences Between Domestic and Foreign Rigid Feedlines

Current products from different countries use varying models and specifications. Imported rigid feedline connectors predominantly use imperial (inch) units, while domestic products use metric (millimeter) units. The conversion is 1 inch = 25.4 mm. Commonly used 13/8" corresponds to domestic 40-mm rigid feedline, and 31/8" corresponds to 80-mm rigid feedline. Due to sub-millimeter differences in inner core and outer diameter dimensions between domestic and foreign products, mixing components from different systems should be avoided.

4. Work Precautions

Before switching to the backup transmitter, the correct frequency must be selected and the position of the coaxial switch for the transmitter to be replaced must be confirmed. Incorrect frequency settings will damage the multiplexer upon startup. After activating the backup transmitter, monitor both forward and reflected power while listening to the signal.

During routine inspections and maintenance, regularly check the temperature of rigid feedline connectors and elbows. Vibration from transmitter fans may loosen connectors over time, causing poor contact, power consumption, and temperature rise that can lead to transmitter failure if not addressed promptly. Maintenance should also include monitoring multiplexer temperature. Generally, as insertion loss increases, multiplexer temperature gradually rises, causing

FM frequencies to drift from operating frequency. This manifests as increased transmitter power, higher VSWR, and potentially VSWR protection activation.

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

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