A Preliminary Analysis of the Principle and Tuning of Self-Supporting Tower-Type Medium-Wave Small Antenna Feed Matching Networks (Postprint)

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Abstract

This paper mainly introduces the principle and tuning process of the antenna feed matching network for this station's self-supporting tower medium-wave small antenna.

Full Text

Introduction

Our station has recently erected a 48-meter self-supporting tower-type medium wave small antenna. The antenna employs a practical self-supporting steel structure without guy wires, featuring a small footprint and convenient maintenance, designed to achieve dual-frequency co-tower broadcasting at 900 kHz and 1206 kHz. The design principle of the antenna matching and duplex network broadens the antenna bandwidth while substantially improving out-of-band attenuation, effectively preventing mutual interference between this station's or adjacent stations' other frequencies. Simultaneously, it creates physical isolation between the antenna terminal and transmitter and implements multiple lightning protection grounding points, thereby significantly enhancing transmitter reliability and operational safety.

Antenna Tuning Procedure

The tuning process for the dual-frequency antenna system was conducted in eight systematic steps. First, we measured the small antenna's input impedance at both operating frequencies by disconnecting all network junctions and connecting the network analyzer's positive terminal to the antenna with the negative terminal grounded, obtaining impedance values of ZA = 38.3 - j13.2 at

900 kHz and ZA = 51.6 - j8.3 at 1206 kHz. Second, we connected L0 to the small antenna while leaving other network components disconnected, adjusting the inductance to find an optimal point where the real parts of the impedance at both frequencies were relatively close, achieving ZA = 45 - j13 at 900 kHz and ZA = 49.5 - j10.4 at 1206 kHz, thus completing the preliminary tuning of network L0.

Third, we adjusted the blocking network composed of L4 and C4 to reject the other frequency (1206 kHz) by independently measuring the parallel resonance point of L4 and C4. After disconnecting other components, we connected the network analyzer and set it to the 1206 kHz range, adjusting L4's inductance to resonate at 1206 kHz. Fourth, we tuned the series resonant network formed by L4, C4, and L3, C3 by disconnecting other connected components, setting the network analyzer to the 900 kHz range, and adjusting L3 to resonate at 900 kHz. Fifth, we adjusted the parallel resonance formed by L1 and C1 by setting the network analyzer to the 900 kHz range and tuning L1's inductance to resonate at 900 kHz.

Sixth, we connected all junctions in the antenna tuning network and adjusted the Γ-type impedance matching network composed of L2 and C2. By connecting the network analyzer to the 900 kHz network cabinet input terminal, we adjusted L2's inductance while simultaneously changing L1's tap position until the input impedance approached the feedline impedance, finally achieving ZA = 50.6 - j1.2 and completing the 900 kHz side tuning. Using the same method, we completed tuning for the 1206 kHz network, obtaining ZA = 50.2 - j1.2 at the network cabinet input terminal.

Seventh, after completing the self-supporting tower small antenna feed network debugging, we connected the transmitter to the antenna and measured the electroacoustic performance indicators using an AM audio comprehensive tester. All three major electroacoustic indicators met the ministry-issued Grade A standard. Eighth, we conducted a full-power trial broadcast using a 1 kW PDM transmitter. Both the 900 kHz and 1206 kHz transmitters operated stably with normal parameter readings, and infrared thermometer measurements confirmed normal operating temperatures for both transmitters and feed networks. Due to climate and weather influences, occasional fine-tuning of the antenna tuning network was required to maintain optimal performance.

Performance Measurement Results

Using a PNA3628DP vector network analyzer, we measured the antenna feed matching network parameters for the small antenna at both frequency points, with results summarized in Table 1 and illustrated in Figure 2 [Figure 2: see original paper] and Figure 3 [Figure 3: see original paper]. The measured input impedances were 50.6 - j1.2 at 900 kHz and 50.2 - j1.2 at 1206 kHz.

Table 1 Small Antenna Feed Matching Network Indicators

Parameter	900 kHz	1206 kHz
Power		
Impedance	50.6-j1.2	50.2-j1.2

Field Testing and Coverage Comparison

Following the trial broadcast, we measured signal field strength at various suburban locations and compared the results with the existing 68-meter guyed tower's coverage. As shown in Table 2 , the field strength was essentially equivalent, with clear broadcast audio quality. In open areas, the small antenna's reception performance was slightly better. In the county's main service area direction, the new tower demonstrated a gain greater than 2 dB.

Table 2 Field Strength Comparison Between Old and New Towers

Location	Old Tower (Guyed)	New Tower (Small Antenna)
Dam Town, Tanghu Village (North 5 km)		
County District (Main Service Area)		Gain > 2 dB

Discussion and Conclusion

With national urbanization development, land resources have become increasingly precious, while medium wave transmission stations typically require large land areas, creating conflict with modern societal development. Medium wave small antennas, characterized by compact size, light weight, and minimal land requirements, effectively address this challenge. As the first 48-meter self-supporting tower-type medium wave small antenna constructed by a station under the Guangdong Radio and Television Technology Center, this installation serves as a benchmark project. After more than two years of operational observation, the system has proven stable and reliable, providing a viable antenna solution for stations with site constraints.

References

[1] Jin Ming. Theoretical Basis and Equipment Maintenance Technical Manual for Medium Wave Radio and Television Transmission Stations. China Radio and Television Publishing House, pp. 659-692.

[2] Wu Jiaxu. Design and Implementation of Diplex Matching Network for Medium Wave Broadcast Transmission Antenna[N]. University of Electronic Science and Technology of China, 2011-10-01.

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