

Operating Principle of UPS and Its Importance in Television Broadcasting: Postprint

Authors: Chen Hao

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Abstract

With increasing material abundance, entertainment activities have become increasingly diverse and colorful, thereby driving substantial advancement in the broadcasting and television industry in recent years, as exemplified by the widespread adoption of non-linear editing and hard-disk broadcasting systems in mainstream television stations. Hardware and software upgrades have increased the amount of equipment required for television program broadcasting, accompanied by increasingly stringent standards for voltage stability. Should the power supply fail to maintain long-term stability, equipment becomes highly susceptible to damage. Therefore, the implementation of UPS (Uninterruptible Power Supply) systems is imperative.

Full Text

The Working Principle of UPS Power Supply and Its Importance in Television Broadcasting

Abstract: As living standards have improved and entertainment options have multiplied, the radio and television industry has made considerable advances in recent years, exemplified by the widespread adoption of non-linear editing systems and hard-disk broadcasting systems in mainstream television stations. Upgrades in hardware and software have led to an increasing number of devices required for television program broadcasting, along with increasingly stringent demands for voltage stability. If the power supply cannot maintain long-term stability, equipment becomes highly vulnerable to damage. For this reason, the introduction of UPS power supply is extremely necessary.

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Author: Chen Hao

1. Related Concepts of UPS Power Supply

The term “UPS power supply” originates from the English phrase “Uninterruptible Power System” (abbreviated as UPS). Compared with traditional power supplies, it offers several advantages: (1) As an uninterruptible power supply, it can provide continuous power; (2) It is equipped with energy storage components and an inverter to maintain constant voltage and frequency. Based on working principles, UPS power supplies can be broadly categorized into three types:

First, **standby UPS** is the most widely used type, providing power failure protection and automatic voltage regulation. Although it requires a relatively long switching time (approximately 10ms), equipment damage is virtually nonexistent. Consequently, it is highly favored in microcomputers, peripherals, and POS systems.

Second, **online UPS** features a more complex structure and more comprehensive functionality compared to the former, capable of handling virtually all power supply issues. However, it is primarily suitable for fields with extremely strict power supply requirements, such as network centers and terminal servers, due to its relatively high cost.

Third, **line-interactive UPS** not only provides filtering but also possesses excellent anti-interference capabilities and extremely short switching times. For these reasons, it can be optimally deployed in network equipment and areas with poor power environments.

2. Working Principle of UPS Power Supply

In simple terms, the working process of a UPS power supply is as follows: The power source is connected to the main unit to form a battery, and then the inverter and other components carried by the main unit convert direct current into alternating current for storage. When the DC circuit cannot function normally, the UPS can fulfill its power supply role. Specifically, when the power supply system is in normal operation, the UPS acts as a voltage stabilizer, protecting equipment from disruptions and damage caused by unstable voltage while simultaneously charging its energy storage device. When the power supply system fails or requires maintenance, the UPS can convert the stored electrical energy through inversion to deliver power to electrical appliances, ensuring their normal operation. In summary, UPS power supply is extremely valuable, enabling power quality to meet the various requirements of equipment. Additionally, it can properly address poor grid conditions caused by centralized power supply.

From the above, it is hardly surprising that UPS power supply is favored across all industries.

3. Importance of UPS Power Supply for Radio and Television Broadcasting

3.1 Ensuring Program Stability Since many radio and television programs are broadcast live, and mistakes in live broadcasts are almost impossible to remedy, it is essential to ensure power supply stability. However, on the one hand, China's large population creates substantial demand and consumption of power resources, resulting in correspondingly large power generation and transmission volumes. This makes the power distribution network inevitably vast and complex, rendering it prone to accidents such as faults and interruptions. On the other hand, all power resources must be transformed by substations before reaching households, but substation voltage fluctuates and is difficult to maintain stable. This significantly hinders smooth program broadcasting, increases equipment wear, and may even lead to equipment failure and safety accidents.

3.2 Addressing Frequency Drift Phenomena Broadly speaking, UPS power supplies can be divided into line-frequency UPS and high-frequency UPS. The former, also called industrial-frequency UPS, is equipped with a transformer and rectifier operating at 50 Hz. The latter, by contrast, features rectifiers with different frequencies, making it more stable in performance. Structurally, high-frequency UPS generally includes the following components: a high-frequency rectifier, inverter, and battery converter. When a generator is operating, if client power consumption fluctuates dramatically, rotational speed will vary significantly, making the output frequency increasingly unstable. This causes signal attenuation and reduced smoothness in radio and television broadcasting. In this regard, UPS power supply can demonstrate its unique advantage by converting electrical power to provide stable frequency for programs, enabling smooth television broadcasting.

3.3 Saving Power and Ensuring Safety Since voltage is generated during current transmission, and cables produce heat as current and voltage pass through, when current is excessive, the actual cross-sectional area of conductors exceeds their effective cross-sectional area, causing resistance to increase. Consequently, heat generation rises, transformer temperature increases, and equipment suffers excessive losses. UPS power supply can generate usable electricity because it can produce harmonic currents and voltages, making effective rectification and control circuits possible. This helps radio and television stations reduce power consumption and ensure smooth program broadcasting.

Furthermore, UPS power supply also fulfills the following functions: (1) It reduces negative impacts on other electronic equipment. Television program production, from acquisition through editing to playback, all depend on electricity. However, in traditional power transmission, current encountering resistance cre-

ates voltage. When voltage rises, motors and other digital control equipment may overheat or vibrate. The harmonic currents used by UPS power supply can significantly reduce the negative impact of voltage on electronic equipment. (2) It reduces accidental tripping. Typically, due to circuit protection devices, if the actual load exceeds the rated load, the power supply automatically shuts off (so-called tripping). Occasionally, short circuits may also occur. When harmonic currents do not reach the rated load, television programs may experience distortion or even short circuits during transmission. UPS power supply activates circuit protection devices in such situations, preventing dangerous broadcasting accidents. (3) It conserves resources. Generally speaking, aside from battery costs and installation space, inverter power supply also affects the backup time that long-duration UPS can maintain. From recording through editing to transmission, every stage of television production may be affected by noise generated by UPS power supply to varying degrees. This can damage program material, render it unusable, and cause resource waste. The application of UPS power supply serves as a strategy to conserve equipment and human resources while ensuring smooth television program broadcasting. (4) It provides power failure protection and automatic voltage regulation. The characteristics of UPS power supply enable it to obtain and store power from the power supply system during normal operation, then release the stored power to provide electricity for television broadcasting during failures or power outages. Additionally, when the power supply system's frequency, input, or voltage is abnormal, it can automatically shut down the rectifier circuit, activate the backup power supply, and convert it into alternating current for future use.

4. Management and Maintenance of UPS Power Supply

Given its characteristics, UPS can provide power during emergencies such as power outages or short circuits. In such cases, broadcasting accidents can be avoided even when sudden changes occur. Therefore, to ensure smooth operations, radio and television stations must guarantee the reliability of their UPS power supplies.

However, in practice, television staff often neglect UPS power supply, particularly regarding inspection and maintenance. In such situations, once failures occur, all station operations inevitably suffer delays. Given this, all personnel at radio and television stations must clearly understand the value of maintaining UPS power supply and find ways to ensure successful program broadcasting.

4.1 Management To ensure stability and reliability during UPS operation, hierarchical management is the mainstream choice. This management strategy essentially approaches from three perspectives—equipment, environment, and video—enabling staff to monitor UPS power supply through network monitoring platforms. During this process, the indoor environment of machine rooms and the operational status of UPS power supply are under real-time monitoring. Based on this, staff can analyze collected power operation data according to

specific indicators and take prompt action after detecting problems, thereby eliminating potential hazards.

4.2 Maintenance Maintenance must address the following points: (1) Select high-quality batteries. With sufficient funding, maintenance-free batteries of superior quality and performance should be the first choice. (2) Use UPS power supply with larger capacity. This not only accommodates system expansion but also reduces operation and maintenance costs. (3) Unless exceptions occur, professionals should use specialized tools to test UPS power supply every four to six months, focusing on internal resistance and terminal voltage. If results indicate these parameters do not meet safety standards, either replace the battery or promptly apply equalization charging. (4) Perform regular charging and discharging. Since UPS power supply connects to daily power systems that normally operate properly with only occasional outages, batteries often remain in float charging state for extended periods. This can significantly reduce the conversion efficiency between chemical and electrical energy, accelerate battery aging, and shorten battery life cycles. Therefore, professionals must perform complete charge-discharge cycles every two to three months. Care must be taken to avoid over-discharging, with discharge cycles determined based on battery capacity and load. (5) Maintain appropriate ambient temperature. According to battery manufacturers, the optimal temperature range for battery operation is generally 20–25°C. Experiments have shown that battery discharge capacity increases with temperature, but its lifespan decreases significantly. Specifically, for every 10°C increase above 25°C, battery life cycle is reduced by 50%. Therefore, to extend battery life cycles, air conditioning and ventilation equipment must be installed to maintain a constant temperature of 20–25°C.

To meet public demand for cultural and entertainment activities, radio and television stations must ensure normal and stable broadcasting. However, given the inherent characteristics of power supply systems, it is difficult to maintain uninterrupted power, inevitably affecting program broadcasting. UPS power supply can provide uninterrupted power while maintaining constant voltage and frequency, making it essential for television stations. It should be noted that UPS power supply also has a limited service life and can fail, so regular maintenance is mandatory.

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(Author Affiliation: Shanxi Radio and Television Station)

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