

## Design and Implementation of Power and Environmental Monitoring for Television Broadcast Control System Equipment Rooms (Postprint)

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### Abstract

With the rapid development of information technology, the equipment quantity of television broadcast control systems is increasing, system scale is becoming increasingly large, and complexity is growing progressively higher. Coupled with the stringent requirements of security level protection for radio and television related information systems, the selection and implementation of a scientific and rational design scheme for data center power and environment monitoring is essential. This paper primarily introduces the design content of the power and environment monitoring system, including the system network architecture and the composition of various subsystems, to achieve functions such as real-time monitoring, information processing, information storage, data analysis, intelligent alarm, historical query, and report statistics, thereby enabling duty management personnel to timely and effectively understand the operating status of power equipment and environmental conditions, and providing maximum fundamental guarantee for the safe, reliable, continuous and stable operation of various critical equipment within the television broadcast control system in the data center.

### Full Text

## Design and Implementation of Power and Environmental Monitoring for Television Broadcast Control System Rooms

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**Abstract:** With the rapid development of information technology, television broadcast control systems have experienced exponential growth in equipment

quantity, system scale, and complexity. Coupled with the stringent requirements of broadcast and television information system security level protection, the adoption of a scientifically sound design scheme for power and environmental monitoring in machine rooms has become essential. This paper primarily introduces the design content of the dynamic environmental monitoring system, including its network architecture and the composition of various subsystems, to achieve real-time monitoring, information processing, information storage, data analysis, intelligent alarm, historical query, and report statistics functions. This enables duty management personnel to promptly and effectively understand the operational status of power equipment and environmental conditions, providing maximum fundamental guarantee for the safe, reliable, and continuously stable operation of all critical equipment in the broadcast control system.

**Keywords:** Information Technology; Broadcast Control System; Power Environment; Monitoring Design; Equipment Operation

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The Chongqing TV broadcast control system is responsible for program broadcasting of 14 television channels, distribution of studio signals, reception and scheduling of satellite signals, and transmission of live outdoor broadcast signals. Strengthening the management and maintenance of the power system and environmental system in the broadcast control room—including site infrastructure, power distribution lines, UPS equipment, precision air conditioning, water leakage detection, temperature and humidity, and fire safety—is particularly crucial for ensuring the normal operation of broadcast control system equipment such as servers, storage devices, switches, switchers, video/audio peripheral devices, and various terminal workstations. Based on the specific requirements of our station's broadcast control room and relevant technical specifications including the *Data Center Design Code* (GB50174-2017), *Safety Requirements for Computer Sites* (GB9361-2011), and *Technical Conditions for Computer Sites* (GB2887-2000), the design incorporates power distribution systems, UPS equipment, precision air conditioning, water leakage detection, temperature and humidity monitoring, fire safety and access control, and video surveillance into the dynamic environmental monitoring system.

## 1. Network Architecture Design for the Power and Environmental Monitoring System

The entire dynamic environmental monitoring system network architecture can be divided into three layers: the equipment layer, communication layer, and management layer, as shown in [Figure 1: see original paper].

### 1.1 Equipment Layer

A large number of monitored devices with varying performance characteristics can be classified into two categories: non-intelligent and intelligent devices. Non-intelligent devices lack data communication interfaces. Environmental parameters such as water leakage monitoring, temperature and humidity, access control power, smoke detection, lightning protection, power distribution monitoring within distribution cabinets, and battery banks fall into this category. These devices lack data acquisition and processing capabilities, requiring the installation of sensors or transmitters. Sensors convert non-electrical signals into standard electrical signals, while transmitters convert non-standard electrical signals into standard ones. This allows standard electrical signals to be transmitted to the dynamic environmental monitoring host via 485 communication cables without affecting equipment operation. Monitoring of non-intelligent devices should adopt distributed acquisition and multi-level electrical safety isolation measures.

Intelligent devices feature data communication interfaces, including most smart power supplies, UPS systems, precision air conditioners, voltage regulators, transformers, and fire control panels. These devices possess data acquisition and processing capabilities and can communicate directly with computers. With appropriate protocols converted to standard formats, various data from intelligent devices can be uploaded to the monitoring host.

Generally, monitored device signals fall into three types: analog, status, and control signals [1]. Analog signals are continuous variables with units and numerical values, such as AC/DC voltage, current, temperature, and humidity, which require conversion to digital values for computer processing. Status signals represent equipment operating states and alarms using binary values (0 or 1), such as equipment alarms (present/absent) and switch positions. Control signals are specific commands sent from the monitoring system to monitored devices to execute actions that change operational states, such as turning off rectifier modules, activating air conditioning, or starting generators.

### 1.2 Communication Layer

The communication layer consists of highly integrated, software-hardware integrated dynamic environmental monitoring hosts and 48-port gigabit network switches. Each monitoring host features 8 analog input ports, 10 digital signal detection ports, 4 digital output control ports, 6 RS232/485 serial ports, 2 USB ports, 1 Ethernet port, 1 audio output interface, and 12 groups of 12V power

supply ports (for sensors and peripherals), with support for expanding 4 additional RS485/232 serial ports. The host includes a built-in Linux-based embedded operating system with functions for data acquisition, analysis processing, linkage control, and alarm notification. It collects and processes information transmitted from the equipment layer, encapsulates monitoring data uniformly, and transmits it to the management platform using standard TCP/IP protocols through the 48-port gigabit network switch. With an embedded WEB server, the monitoring system can be viewed and managed via IE browser.

### 1.3 Management Layer

The management layer comprises the dynamic environmental monitoring management platform. Monitoring operation terminals use PCs with Windows 7 operating systems and installed human-machine interface software for the monitoring system. The platform can monitor the real-time operational status of power equipment and air conditioning systems, as well as various environmental parameters in the machine room. It enables remote manual or automatic control of monitored devices, accurately and rapidly locates fault points based on equipment status and numerical trends, generates alarm information, and reports diagnostic results to duty management personnel through multiple means (sound, light, voice, telephone, SMS, email, etc.) to facilitate timely response. Through a rich display interface, users can query real-time data and automatically generate relevant reports for maintenance personnel analysis, with options to print or export query results and reports.

## 2. System Composition and Functionality

The Chongqing TV dynamic environmental monitoring management system primarily consists of six subsystems: power distribution monitoring, UPS monitoring, precision air conditioning monitoring, temperature and humidity detection, water leakage detection, and video surveillance.

### 2.1 Power Distribution Monitoring Subsystem

The machine room power distribution system complies with the requirements of the State Administration of Radio and Film Order No. 62, *Regulations on Safety Broadcast Management for Radio and Television*, and the implementation rules for television centers, meeting national and industry technical specifications and hierarchical configuration regulations stipulated by the State Council's radio, film, and television administrative department. The system employs independent low-voltage power supply circuits from two different dedicated process transformers, delivered to the broadcast control room via four dedicated cables. After passing through two ATS switches (with automatic and manual mutual switching functions), they connect to primary and backup UPS systems, forming independent dual-bus architecture. The system primarily performs remote measurement of three-phase input/output voltage, current, frequency, total active

power, and total apparent power, as well as remote signaling of switch status, phase loss, overvoltage, and undervoltage conditions. The monitoring interface is shown in [Figure 2: see original paper].

## 2.2 UPS Power Monitoring Subsystem

The UPS power monitoring subsystem interface is shown in [Figure 3: see original paper].

## 2.3 Precision Air Conditioning Monitoring Subsystem

The machine room is equipped with six intelligent precision air conditioners connected to the monitoring host through protocol conversion. The system primarily collects data on power status, cooling state, supply air temperature and humidity, return air temperature and humidity, voltage over/under conditions, overcurrent, temperature/humidity over/under limits, compressor faults, compressor operating status, heating state, cooling state, fan status, power on/off, temperature adjustment, and temperature/humidity range settings. The monitoring interface is shown in [Figure 4: see original paper].

## 2.4 Temperature and Humidity Detection Subsystem

Temperature and humidity monitoring has been implemented in all critical areas of the machine room, with 21 integrated temperature and humidity sensors installed to collect relative humidity and absolute temperature values in different zones, such as above cabinet return air locations, under ceiling areas, and air conditioning outlets. Sensors output standard 4-20mA current signals processed by the monitoring host via RS485 serial connections. The monitoring software displays and records real-time values from each sensor, with configurable upper and lower alarm limits for temperature and humidity that trigger alerts when exceeded. The monitoring interface is shown in [Figure 5: see original paper].

## 2.5 Water Leakage Detection Subsystem

To precisely locate water leakage faults around precision air conditioners and near water pipes under the raised floor, three water detection cables have been deployed to monitor and promptly alert on leakage from air conditioning units and plumbing systems. The system employs linear detection technology based on the liquid conductivity principle, consisting of two spiral conductive sensing wires and a controller. The sensing cables are installed exposed along the floor near air conditioners and water pipes, with a termination end forming a closed circuit. When water contacts the sensing cable, the capacitance changes, allowing the controller to detect the leakage fault and precisely calculate the leak location based on relevant data. During cable installation, care is taken to avoid metal objects to prevent false alarms, with cables fixed to the floor using adhesive mounts rather than suspended installation to ensure timely detection. The system is illustrated in [Figure 6: see original paper].

## 2.6 Video Surveillance Subsystem

The video surveillance system requires 30 camera positions in the machine room, utilizing 960P high-definition network infrared dome cameras for daily video monitoring. The system topology is shown in [Figure 7: see original paper].

The storage system is designed for 30 cameras at 2Mbps bitrate each, recording 24 hours daily with 40-day data retention. The storage calculation is:  $2\text{Mbps} \div 8\text{bit} \times 3600\text{ seconds} \times 24\text{ hours} \times 40\text{ days} \times 30\text{ cameras} \div 1024 \div 1024 = 25\text{ TB}$ . The system employs one network video recorder with 10 bays configured with 4TB surveillance-grade hard drives, providing 28TB effective storage space after RAID5 formatting. For security redundancy, two network video recorders are configured for simultaneous recording. The surveillance system provides real-time monitoring, retrieval playback, and system management functions, with detailed functionality listed in .

**System Management Functions:** - Device management (device addition/modification, parameter configuration, advanced settings, connection testing) - Device inspection (inspection plan management, automatic/manual inspection, result display and processing) - Electronic map management (hierarchical tree structure management, device-map association, map interlinking) - Scheduled tasks (recording plan management, deployment plan management, import/export, parameter settings) - Alarm management (tree-structured device display, alarm type/level management, alarm linkage settings) - Server management - User management (account management, system permissions, device access permissions, user information lists) - Log query (multi-level filtering by type, organization, date, keywords, with export and print functions) - System settings (schedule configuration, storage management, log deletion, data management)

The video surveillance software interface is shown in [Figure 8: see original paper].

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

*Source: ChinaXiv – Machine translation. Verify with original.*