Principle Analysis of Three-Level Data Center Alarm System (Postprint)

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Abstract

This paper presents an independently developed system by our station that, through sampling and analysis of machine room transmitter equipment, transmitter power supply systems, and signal systems, and employing 4N35 and CD4068 for data acquisition and processing, provides a comprehensive stepwise alarm scheme for abnormal states of critical equipment and key locations in the machine room.

Full Text

Analysis of the Principle of the Three-Level Alarm Device for the Machine Room

Abstract: This paper presents a self-developed comprehensive stepwise alarm solution for abnormal conditions of critical equipment and key locations in broadcast transmission machine rooms. The system employs sampling and analysis of transmission equipment, transmitter power supply systems, and signal systems, utilizing 4N35 and CD4068 components for signal acquisition and processing.

Keywords: Time controller; Startup warning; Transmitter high-voltage loss alarm; Color bar signal alarm

Safe broadcasting represents the foremost priority for transmission stations, prompting continuous reflection among technical staff on enhancing operational security. Establishing intuitive, reliable equipment monitoring, detection, and fault alarm systems has become essential work. As a provincial-level transmission station, our facility places particular emphasis on safe broadcasting, requiring timely alarms and rapid response when broadcast system anomalies occur. Our machine room comprises multiple areas including a duty room, south equipment room, north equipment room, and power distribution room, covering a large area. With most periods staffed by a single operator who cannot comprehensively observe all areas during duty rounds, establishing a reliable and stable automatic alarm system proves particularly critical. Under leadership requirements and support, our technical personnel conducted in-depth analysis and discussion on automatic alarming for critical equipment and locations, ultimately determining a stepwise alarm approach to establish a complete alarm system.

The three-level alarm system operates as follows [Figure 1: see original paper]. The first level provides real-time alarming: when external power supply anomalies occur, transmitters experience protective high-voltage loss, or signal abnormalities arise, a buzzer in the duty room alarms immediately. The second level implements a 30-second delay: if first-level alarm conditions persist without resolution, or if startup warning alarms remain unaddressed, a high-decibel alarm bell with flashing light activates within the machine room. The third level employs a 50-second delay: if faults from the first two levels continue without restoration, a high-decibel alarm bell activates in the dormitory area, indicating a serious fault requiring all on-duty personnel to respond.

2. Circuit Design and Principle Analysis

Analysis determined that the machine room alarm system should extract alarm signals from critical equipment and locations while achieving interoperability with the existing centralized control system to realize comprehensive alarm functionality. The circuit design divides into two main parts.

2.1 Alarm Sampling and First-Level Alarm Circuit

2.1.1 Signal Abnormality Alarm This alarm samples from the color bar instrument controller. Our station employs a multi-channel audio color bar monitor manufactured by British company Chromatec. An optocoupler N1 (4N35) is installed at the alarm output of the color bar instrument control box for isolated sampling, with the alarm signal connected to the first-level alarm system [Figure 2: see original paper]. Each frequency has three signal sources plus a demodulated broadcast signal after transmitter output detection, totaling four signal paths. The three signal source samples enter the color bar instrument from our signal cabinet's audio distributor, while the transmitter output detection samples enter through our self-developed detection modulation depth display. The color bar instrument processes these four signals per frequency. Upon signal abnormality, the color bar instrument triggers an alarm, activating the optocoupler N1. This causes the 24V DC relay to energize, sounding the first-level buzzer and simultaneously sending a 220V live wire control signal to the second and third-level alarm delay circuits.

2.1.2 Transmitter High-Voltage Loss Alarm This alarm samples from each transmitter's high-voltage second-gear relay. Relays J1 and J2 (for frequency 1) are installed to interface with the first-level alarm system [Figure 2: see original paper]. With five frequencies at our station, five independent alarm circuits are implemented, though this paper introduces only two frequencies for illustration.

The time controller selected is the KG316T model, with activation times set consistent with transmitter broadcast schedules. The operating principle is as follows (using frequency 1 as example): Relay J1 is the high-voltage loss relay installed on frequency 1's main transmitter [2], while relay J2 serves the backup transmitter [1]. Both relay coils derive voltage from the transmitter's high-voltage second-gear relay. Contacts J1-1 and J2-1 are normally closed and connected in series; contacts J1-2 and J2-2 are normally open and connected in parallel. The time controller and manual switch 1 are connected in parallel, with the manual switch providing maintenance convenience and ensuring alarm functionality remains operational during time controller failures.

When transmitters are not energized with high voltage, J1-1 and J2-1 remain closed. If outside the startup period, the high-voltage loss switch remains open and the time controller stays de-energized, leaving the buzzer silent and J1-2/J2-2 open with indicator lights off. During startup periods, if the high-voltage loss switch remains open, the time controller energizes, the buzzer alarms, and J1-2/J2-2 close to illuminate the indicator lights. The control signal for second and third-level high-voltage loss alarm delay circuits derives from the 220V live wire at the buzzer front end. The high-voltage loss alarm for frequency 2 and other frequencies operates on identical principles [3].

2.2 Startup Warning Alarm

Early shift startup warning: To avoid startup delays, a time controller provides temporal warning control, with its signal directly connected to the second and third-level alarm systems [Figure 3: see original paper].

This alarm employs the KG316T time controller to output a 220V live wire control signal, with activation times configured for early shift testing periods. Without first-level alarming, the time controller's 220V live wire control signal directly feeds into the second and third-level alarm delay circuits.

2.2.1 Power Supply Circuit Selecting appropriate alarm control signals represents a critical consideration. Our station operates five frequencies with total transmission power reaching 220kW, requiring control signals with strong anti-interference capability. Analysis determined that 220V, as a strong electrical signal, inherently possesses robust anti-interference properties. Directly using 220V as the alarm control signal through a time controller simplifies circuit design, while filtering through a power filter and voltage division enhances stability and reliability. A 24V/2A switching power supply provides power for the color bar instrument's first-level alarm device and serves as bias power for second and third-level alarm circuits.

2.2.2 Alarm Switch K1 Alarm switch K1 should remain in the ON position during normal operation and may be used during maintenance or alarm cancellation. During normal operation, it must be set to the "ON" position.

2.3 Second and Third-Level Alarm Circuits

The second and third-level circuits implement delayed alarming functionality [Figure 3: see original paper]. The delay circuits process signals from first-level alarms, providing progressive escalation when faults persist.

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

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