Overhead Line Fault Section Positioning System Based on Wireless Sensor Network

Abstract. This paper introduces overhead line fault detection and location system as the core of industrial control computer. The combination of software and hardware, the methods of current rate of change and zero current detection are used, and so the accuracy of short circuit fault detection is improved. The features of ground phase voltage drop and the 5th harmonic current are integrated. Zigbee wireless chips are used to make into independent signal transmission system. The system has been put into operation, running in good condition.

of the line current. Here selection of the open-type current transformer in order to facilitate installation.

![Diagram of 5th harmonic current detection circuit](image)

**Fig.2.** Short circuit fault detection circuit schematic diagram

The resistance R of the resistor in parallel across the current transformer used to transform the current signal into a voltage signal. Through the diode VD rectifier and filtering capacitor C1, the AC voltage signal Change into a DC voltage signal, and then the resistance of R1, R2 partial pressure are then given to the LM393 comparator inverting input and the inverting input, the comparator is used to achieve short-circuit fault discrimination. Short-circuit fault discrimination as follows: As resistor R1 and R2 are equal, the voltage of noninverting input V+=2V−, the voltage of noninverting input is higher than the inverting input, according to the principle of the comparator the output of the comparator is high potential. When the measured line produce short-circuit fault, the current will suddenly increase, corresponding to the DC voltage signal will also suddenly increase. However, due to the termination of the noninverting input is connected a capacitor and the inverting input is not connected capacitor. Thus, when the voltage mutation occurs, the potential of inverting input terminal rise faster than the noninverting input terminal increase, causing the inverting input of the potential is higher than the noninverting terminal potential. According to the principle known of the comparator, the voltage output UOUT is low.

**B. Ground fault detection principle**

At present, the main method of the existing single-phase ground fault detection are [7]: zero sequence current method, capacitive current method, the first half-wave method, the fifth harmonic method and the signal injection method. When the lines of a phase to ground fault, the phase voltage will be reduced, so that the three-phase voltage will be asymmetric, usually there will be inductive load grid, line current will be distorted, produce large amounts of high-order harmonic current, appears 3, 5, 7 ...... harmonics. However, since the 6 ~ 66kV distribution network belongs to the neutral point non-effectively grounded system [8]. Therefore, the third harmonic current can not be through the grid, other harmonic components accounted for a small proportion, so the 5th harmonic is the most obvious.

**Fig.3.** 5th harmonic current detection schematic diagram

Because of this, we use the fifth harmonic current method, by detecting the line current; extract the 5th harmonic component, depending on the size of the 5th harmonic current to determine the ground fault. Detection circuit is shown in Fig.3. First, the line current is measured with a special open-type current transformer, separated the 5 harmonic by selective circuit, and then changed into a DC voltage signal by the rectifier circuit, the final outputted by the comparator circuit. There may be some higher harmonic current in the normal circuit due to the presence of non-linear load in the circuit line. Therefore, the comparative output is used in here. According to the predicted values of the 5 harmonic current in the normal, the baseline value of the comparator is to be determined. When 5 harmonic current is greater than or equal to the reference value of the comparator, the output is high potential. It can be judged to be ground fault; otherwise, the output is low, it is non-ground fault. In addition, to further improve the reliability of the ground fault detection [9], we also detect circuit phase voltage, the same as one of the necessary conditions to determine the ground fault. When the line voltage decreases, while the 5th harmonic current detection circuit outputs a high potential at this time determined to ground fault, the other cases are non-ground fault.

**Installation and application**

After multiple simulations detection circuit to meet the requirements, then to product the PCB, weld the component, assemble. The system is installed in a line site in Henan, run in November 2009. The total length of the installation of line about three kilometers, the line voltage rating of 6kV load current of 300A. The power supply system is the neutral point ungrounded system. According to the situation of the distance range, we selected seven detection points. The whole line to install a total of 21 fault detection devices, each test point (A, B, C) to install three detection devices. The average distance between the two detection points is about 450 meters. Detection devices on-site installation and application picture is shown in Fig.4. The host part is placed in the control room, which mainly include: industrial control micro-computers, wireless receiver, monitors, etc…The main part of the wireless receiver device is a ZigBee wireless communication module, whose role is to receive the detection signal through the wireless transmitter step by step.

**Fig.4.** Detection device installing picture

The IPC gets the data wired, analyzes and processes them. Taking Kingview 6.51 software as development platform [10], the monitoring program and display with many functions are designed, such as communication, fault display, the database stores, SMS messages, etc. Home page of the picture is shown in Fig. 5.

**Fig.5.** Picture page
It contains seven conversion interfaces. Where the first three are the screens of fault display, the remaining four screens are the alarm of history, database, SMS sending and exit button. The main function of the control host as follows: (1) Fault display function. Fault display is divided into graphical display and the report shows. (2) Database function. When the system detects a failure, the relevant fault information is stored in the corresponding database. Classification to query in a database, according to the time or the type of the fault, can also generate reports, print at any time or at the setting-time. Database is also directly connected with Excel to save the information in the form of Excel tables, user-friendly; (3) SMS sending. When a fault occurs, first generate the corresponding fault information, there are time, location, fault type, and then the fault information will be sent directly to maintenance personnel mobile phones with the TC35T SMS sending module connected to the computer interface, in order to deal with failure, shorten the time of failure blackout.

Conclusions
The results of the system operation show that. The results of the system operation show that the accuracy rate of the short circuit fault detection close to 100% and accuracy rate of the ground fault detection up to 80%, and can achieve reliable transmission by relay and step, and the running costs of the system is significantly reduced, to achieve the desired goal. The safety and reliability of the power supply system becoming more demanding, urgent need for reliable fault detection and location devices. The system can be timely detection of line faults, quickly find the failures, fast processing, and rapid restoration of electricity, to reduce the outage frequency and outage time, it has great significance to improve the safety and reliability of power supply. Therefore, this technology has good prospects for promotion and application.

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