Hindawi
Journal of Control Science and Engineering
Volume 2023, Article ID 9892508, 1 page
https://doi.org/10.1155/2023/9892508

Retraction

Retracted: Electrical Line Fault Detection and Line Cut-Off Equipment and Control

Journal of Control Science and Engineering

Received 15 August 2023; Accepted 15 August 2023; Published 16 August 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Y. Fu, "Electrical Line Fault Detection and Line Cut-Off Equipment and Control," *Journal of Control Science and Engineering*, vol. 2022, Article ID 3857938, 6 pages, 2022.

Hindawi
Journal of Control Science and Engineering
Volume 2022, Article ID 3857938, 6 pages
https://doi.org/10.1155/2022/3857938

Research Article

Electrical Line Fault Detection and Line Cut-Off Equipment and Control

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Received 23 May 2022; Revised 17 June 2022; Accepted 22 June 2022; Published 6 July 2022

Academic Editor: Jackrit Suthakorn

In order to locate the leakage fault location of low-voltage electrical lines, cut off the power supply of electrical lines, and ensure the safety and reliability of the power supply network, this paper proposes an electrical line leakage fault detection system based on a signal trigger. Based on the research on the current leakage protection system of low-voltage electrical lines, the author puts forward that the leakage current of the selected test analog trigger signal is not less than twice the maximum value of the normal leakage current of electrical lines and equipment with STC15F2K60S2 single-chip microcomputer as the control core. The experimental results show that 30 mA is preferred for the sensitivity of the leakage fault test signal. When the rated leakage action current is equal to or less than 30 mA, the protection action time is required to be less than 0.1 s, and when the rated leakage action current is greater than 30 mA, it is required to be less than 0.2 S. The device is a supplement to the traditional leakage protection device. According to the comparison between the indirect leakage detection and direct leakage detection results and the actual leakage position distance, the error is within 10%. It is proved that the system meets the actual needs and improves the protection performance of the leakage protection system of low-voltage electrical lines.

1. Introduction

Power transmission line is the only medium of power transmission in the power system and an important part of the power system. High voltage transmission lines have the characteristics of a long paths, mostly in the field or beside the urban road, so line faults often occur. In case of fault of high-voltage transmission line, if the reclosing cannot be completed successfully, the power system will stop the power supply. Frequent power outages will affect the reliability of power supply, fail to serve power customers well, affect the power supply income of power companies, and may affect the safe and stable operation of regional power systems [1]. Therefore, in the case of a power line fault, if the fault location can be determined quickly and accurately, it can improve the maintenance efficiency and significantly reduce various economic losses caused by power failure caused by line fault. Therefore, improving the fault location accuracy of transmission lines has important practical significance for power supply enterprises and power customers. It is a key research topic for power enterprises and scientific research institutes at home and abroad. Due to the development of the urban economy and the shortage of land resources, the total length of cable transmission lines increases year by year, and the operation time of cable lines continues to increase. At the same time, due to the influence of construction level, municipal construction, service conditions, and other factors, the faults of cable lines continue to increase and the types of faults are diverse. However, since the cable is laid below the ground, in the cable tunnel, channel, and pipe row, when the fault occurs, the maintenance personnel cannot directly observe the fault point. The fault location needs to be carried out in advance, and then the covering on the cable fault point can be removed for maintenance [2]. Therefore, the accuracy of cable positioning will directly determine the time of troubleshooting. If the fault point can be located quickly and accurately, the fault can be repaired in time and the power supply can be restored as soon as possible, which can effectively improve the reliability of the power supply, improve the power consumption satisfaction of users, and provide a strong guarantee for building a strong smart grid.

2. Literature Review

Salehimehr et al. use an expert system method to detect the fault of high-voltage power cable, can regard the knowledge base as the basic database, effectively update the knowledge base based on rules in the analysis, and complete the comprehensive extraction of key fault information. The expert system designed in the research, it has a man-machine interface to judge and make decisions, and the system also realizes the three components of fault diagnosis, rough measurement, and precise measurement. Combined with the actual situation of wavelet transform and fault diagnosis, it can achieve a more accurate effect of power cable fault measurement [3]. Rakesh et al. advocated using the impedance method to solve the problem of line fault in the research, which means that when there is an obvious fault difference, the interval between fault points can be determined by using impedance method to analyze the measurement points and fault points and analyzing the impedance value and the impedance ratio. However, it is necessary to set a uniform line in the analysis, and the use of impedance method can effectively reduce the cost. This fault detection method is more applicable to simple circuits, but not too complex circuits [4]. Kim et al. pointed out that the problem of cable fault location can be realized by a wavelet algorithm. In the research, the pulse current test method wavelet transform method is proposed. After processing and decomposing the recorded wavelet data, it is reconstructed, and the signal distance of the pulse is determined based on the premise of data analysis. During the analysis, it is determined that the impedance method can be used for single terminal ranging. Combined with the actual measurement results of current and voltage, it is found that this method can achieve 2.4% of the average measurement accuracy, but 4% of the measurement error. Therefore, the measurement accuracy still needs to be further developed [5]. Yang et al. analyzed the theoretical model of the s injection method and proposed that by connecting the connection points of signal current value, it can be seen that the fundamental frequency between bus and grounding wire exceeds n but is lower than $N+1$, and then the existing fault points can be found by signal detector equipment. After the power transmission is stopped, the power detection instrument is matched with the signal injection method, which can obtain a more accurate fault point search, but it should not be used when the signal is too weak and the distance is too long. When there are branches, it is still necessary to ensure that the detection branch line used reaches 6 m [6].

The high-voltage power grid is not easy for people to touch, while the low-voltage power grid has a large coverage, much electrical equipments, and more opportunities for people to touch. Electric leakage accidents of low-voltage power supply lines will occur due to factors such as damp electrical lines, overload power consumption in peak power consumption, aging or damage of household line and outgoing line insulation, rupture of rubber insulated line sheath, flexible cable sheath and insulation layer, improper selection or loose falling off of flexible cable joint insulation binding, etc., resulting in electric shock, fire and other disasters. Therefore, the goal and key point of this research are to realize the alarm before the threshold value or cut off the line power supply in time when the threshold value is reached through the electrical line leakage fault detection and alarm system [7]. Abnormal current or voltage signals will appear when there is a leakage somewhere in the low-voltage electrical line. By detecting and processing these trigger signals, we can judge which section of the electrical line has a leakage fault and the approximate location of leakage, to give an alarm prompt and start the corresponding leakage protection actuator.

3. Research Methods

3.1. System Composition and Principle

3.1.1. System Composition. Part of the residual current, or zero-phase current, occurs when a drop occurs in a low voltage line. The detector is designed with zero phase current, which is a signal to indicate leakage. The detected material is a zero-one phase current transformer. After the fault of the line, the equilibrium of the current vectors of the phase line and the center line is not equal to zero, thus generating the electric field. After amplifying, comparing, and converting to analog-to-digital, the signal is transmitted by sending it to a microcomputer. With the help of loss detection, many tests and diagnostics have been completed of the digital signal, including fault lines and similarities, displaying this information with LEDs, and making sound and seeing the alarm. safety warning [8, 9]. Figure 1 shows the structure of the electrical protection circuit breaker.

3.1.2. Electric Leakage Fault Detection Principle of Electrical Circuit. Electrical protection devices shall be placed in the electrical meter on the grid or at a distance. When the low-sequence circuit currents are constant and there is no damage, the zero-sequence circuit of the current coming and going through one end of the circuit must be zero and the vacuum pump should be ready; When a leakage current occurs in one of the electric fields, a portion of the electric current flows from the atmosphere to the Earth, causing the difference between electrical and electronic equipment. After completing the signal occur several times, depending on the size of the leakage current signal, we can filter the distance of the leakage material to see with the help of different algorithms correct. In addition, depending on the number of leaks, we can identify the area near the leak where the leak occurs.

3.2. System Hardware Implementation. A visual pump is installed in the low-voltage line to identify the zero-phase section of the line. When there is no damage to the line, no power supply, and no line loss, the sum of the values of the line current of the line is zero; When the line fails, a single-

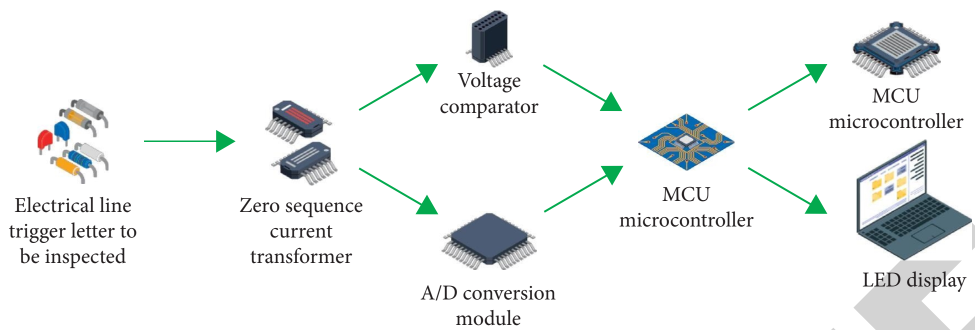

FIGURE 1: System structure block diagram.

phase grounding fault current I_d will inevitably be generated. Therefore, the output range of the trigger current signal is 10~50 mA. In + and in—of the U_1 operational amplifier are the signal differential input terminals. The gain amplification factor $B = (1 + ((R_2 + R_3)/(RW + R_1)))$ can be set to 1~10 times through the potentiometer [10].

The signal to support the shock during operation is also an analog signal. An analog-to-digital converter must send this to the MCU for calculation. Analog-to-digital conversion is the process of converting analog input to digital values, and the converter circuit to analog-to-digital is an integral part of the entire data collection section. A-10 bit A/D conversion chip TLC1543 is used to follow the system operating index and signal characteristics, and its analog input voltage corresponds to the value of 0~1024 and is 0~ + 5 V [11]. In-circuit connections, pin A0 is the end of the signal input drop. Changing the CS end edge will restart the internal gauge and control the activation. ADDRESS (pin 17) is a 4-bit serial address used to select the next analog signal input or signal conversion experiment. The output file is the final 3-state serial output after conversion A/D. It can be connected to a microprocessor or peripheral serial port, and the length and type of data are output. optional modification.

When the signal is converted to a digital signal, it is sent to the MCU for operation. MCU is an important part of data management in all control circuits. The most recent update features the 8051 series MCU STC15F2K60S2, which has two independent ports; The built-in crystal oscillator and resets circuit greatly improve the interference resistance; It has multiple input/output ports, high speed, low power consumption, and most importantly low cost. This makes the system suitable for many applications and changes.

If the whole electrical circuit works normally and there is no leakage fault, the working state indicator is in the green flashing state, and its working state is controlled by the single-chip microcomputer I/O port P1.1 [12]. In case of leakage fault, the single-chip microcomputer program will set port P1.3 high, the triode VT_3 will be turned on, the red alarm light will flash, and the buzzer will give an alarm sound at the same time; The flashing yellow light indicates that the single-chip microcomputer self-starts the leakage protector and cuts off the electrical circuit [13, 14].

3.3. Software Design

3.3.1. Software Workflow. The operation of the software system is shown in Figure 2. The system is in low power standby mode when the electrical circuit is normal and no damage; The signal loss model is installed into an electronic circuit, upgraded to hardware, and then converted to analog-to-digital and sent to a single microcomputer for counting and analyzing check. Depending on the groundwater availability, the location of the fault is determined and the results are transmitted to the equipment by serial connection. If the electric current passes through the hard circuit, the protection device must be controlled and operated by the microcomputer alone to ensure the safety of the electronic device and prevent interference intersection of electrical equipment and staff [15].

3.3.2. Leakage Current Fault Detection Algorithm. In the event of a fault in the circuit, it is necessary to calculate the leakage current in the circuit to determine the location of the circuit leak, and to determine the voltage between the average point MQ and the load average point ml. In the low-voltage electrical circuit, there are three-phase voltages (U_{L1}, U_{L2}, U_{L3}) connected with the neutral point MQ. At the load end, three load impedances Z_1, Z_2, and Z_3 are connected in a star shape, and two neutral points MQ and ml are connected through impedance Z_{QL}, the voltage drop on this impedance is U_{QL}, and the calculation formula of U_{QL} is as follows:

$$U_{QL} = \frac{(U_{L1}/Z_1) + (U_{L2}/Z_2) + (U_{L3}/Z_3)}{(1/Z_1) + (1/Z_2) + (1/Z_3) + (1/Z_{QL})}. \quad (1)$$

The conventional setup consists of a three-phase filter connecting three X capacitors to the neutral medium and conducting them through a Y capacitor or filter cover. In the case of a balanced capacitor circuit, the leakage current must be neglected. On the other hand, when the maximum phase difference is reached, the mains reach the maximum value of the current range [16, 17]. The reason for the discrepancy is the tolerance of the capacitor values and the inconsistency of the capacitance in the power supply. Therefore, the key element of leakage current is the voltage U_{QL} generated by the imbalance of capacitors C_{X1}, C_{X2} and C_{X3}. For most

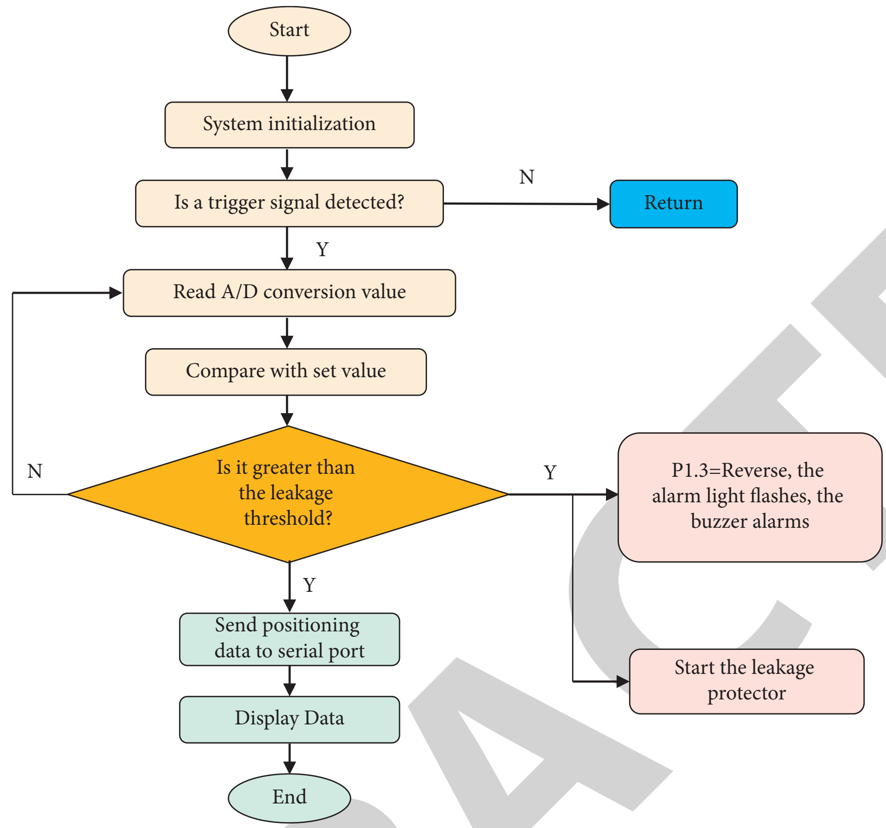

FIGURE 2: Software workflow.

filters, the rating is the same. The leakage current $I_{\text{leak max}}$ generated by the voltage drop U_{QL} at the capacitor C_Y can be determined according to the following formula:

$$I_{\text{leak max}} = U_{QL} \cdot j\omega \cdot C_{Y_n}, \tag{2}$$

where $\omega = 2 \cdot \pi \cdot f$, the tolerance of the rated value of the capacitor in the passive filter is $\pm 20\%$. The highest voltage drops of C_Y occurs when two X capacitors have the minimum tolerance and one capacitor has the maximum tolerance. In addition, it is assumed that the tolerance value of C_Y is the largest. Substituting these assumptions into formulas (1) and (2), the leakage current is the following formula:

$$\left|I_{\text{leak max}}\right| = \omega \cdot C_{Y,\max} \frac{U_{\max} C_{X,\max} - U_{\min} C_{X,\min}}{C_{X,\max} + 2C_{X,\min} + C_{Y,\max}}. \tag{3}$$

Then, the digital return value A_d of the trigger signal after analog-to-digital conversion is the following formula:

$$A_d = \frac{I_d \times R_d}{U_{\text{ref}}} \times 1024, \tag{4}$$

where I_d is the amplified trigger current signal, R_d is the load end resistance of 100 Ω, U_{ref} is the reference voltage of A/D conversion, 1~5 V is taken, and 1024 is the maximum resolution of ten bit A/D converter.

3.3.3. Software Anti-Interference Design. Because the operation of the pump is usually outdoor, there is a lot of signal interference, and the interference of electromagnetic pressure by the electric field can cause signal analog input distortion, signal control confusion, control failure, and operation failure. accident, address or bus information confusion, etc. Therefore, the design of the anti-interference system is associated with a high degree of reliability in the immune system. In addition to strengthening interference hardware, interference software must be specially designed [18]. If the system program is running and entering a dead loop, the support program can be run by 0000H. The reset circuit is connected to the reset terminal of a single-chip microcomputer, and the capacitor and grounding resistors provide power to the reset circuit, so the program is run by the 0000H unit. Reset Circuit and Manual Reset Circuit can provide a reset signal higher than 10 mA for the reset chip. The MAX813L reset chip offers real-time monitoring and power control. When the system program is caught in a dead cycle or when the power changes suddenly, it does not cause a crash, read data, write errors, or malfunction, so restart the system to the faulty state [19, 20].

4. Result Analysis

The environment for experiment and debugging, in which L_1, L_2, and L_3 are three-phase electricity, PE is the protective zero line, and RCDW is the leakage protector, which can ensure the safety of the experiment. Simpson228 digital ELCB tester is selected to test and debug the leakage fault detection device system [21, 22]. According to the relationship between the trigger signal and the set voltage value,

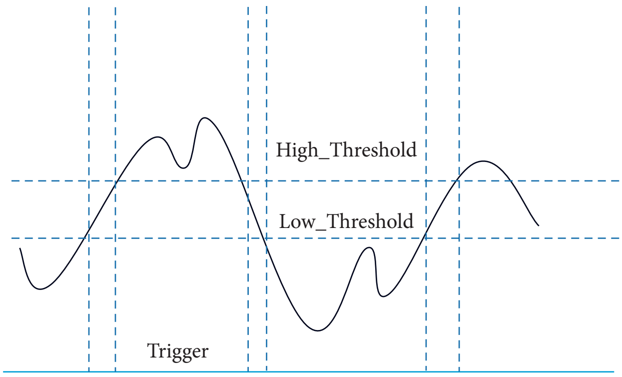

Figure 3: waveform of leakage current analog trigger signal.

Table 1: Test results of indirect contact leakage fault.

Leakage current detection value (mA)	Operating current (mA)	Fault location (m)	Action time (ms)
6.4	30	19	68
6.6	30	17	70
6.2	30	21	60

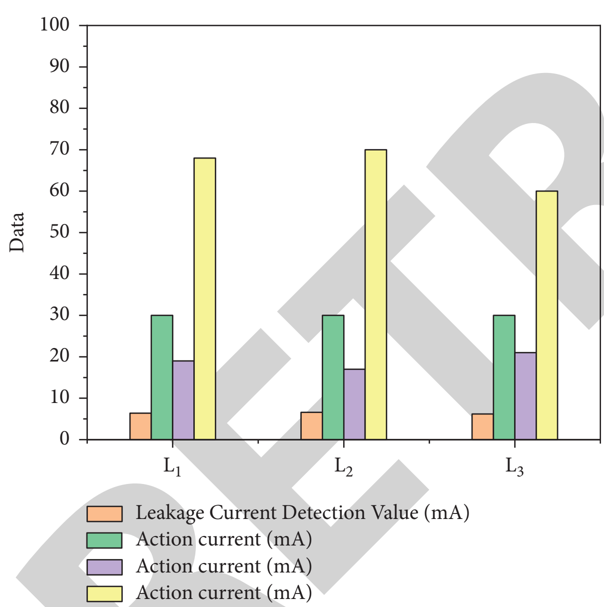

Figure 4: Data diagram of indirect contact leakage fault test results.

Table 2: Test results of direct contact leakage fault.

Leakage current detection value (mA)	Operating current (mA)	Fault location (m)	Action time (ms)
26	Any	16	35
33	Any	13	36
38	Any	11	33

a variety of trigger conditions can be set, as shown in Figure 3. The leakage current of the selected test analog trigger signal shall not be less than 2 times the maximum value of the normal leakage current of electrical lines and equipment.

According to the comparative analysis of leakage fault simulation test data and referring to the requirements of in the national standard "Leakage Current Operated Protector (residual current operated protector)" GB 6829-86, the indirect contact leakage test results are shown in Table 1 and Figure 4, and the direct contact leakage test results are shown in Table 2 [23].

Through the test of analog leakage signal and the test results, it can be concluded that the whole system operates stably, the fault detection is accurate, and there is no crash. According to the comparison between the indirect leakage detection and direct leakage detection results and the actual leakage position distance, the error is within 10%, which can meet the detection and positioning requirements of an electrical circuit leakage fault [24–26].

5. Conclusion

Taking the single-chip microcomputer as the control core, the system proposes to detect the leakage fault based on the zero-sequence circuit as the trigger signal, which can detect and locate the faults in time after the leakage fault occurs in the low-voltage power supply line. It plays a preventive role in the evolution of small fault into a large fault, to reduce the scope of fault power failure, facilitate the search for leakage fault, shorten the time of leakage power failure and improve the reliability of power supply.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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