

# Common Fault Analysis of Digital Circuit Breaker

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## Abstract

**Related data shows that: about 80% of the faults of digital circuit breaker are mechanical faults, the mechanical characteristics monitoring of digital circuit breaker is conducive to the early detection of various hidden faults, reduce the probability of equipment failure, so as to enhance the reliability and safety of the whole power system. Based on this, the common faults of digital circuit breaker are deeply analyzed in this paper.**

## Keywords

**Digital Circuit Breaker; Fault; The Power System.**

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## 1. Introduction

In recent years, with the increasing demand for electricity, the power system is also developing rapidly, especially the accelerated construction of smart substation, which has higher requirements for equipment reliability. As arc-extinguishing and insulation equipment, digital circuit breaker plays an important role in protection and control of power grid system. If the digital circuit breaker breaks down, the power grid system can not run stably, and even cause huge economic losses.

## 2. Protection of Digital Circuit Breaker

Digital circuit breaker not only has the role of on and off the load current, on of the short circuit current and bear the corresponding time, under the support of protection device which can realize automatic trip, eliminate the fault, in the process of load transfer or investment, accurate open and close, the equipment failure or power transmission and distribution lines, bus bar fault occurs, can be selectively to action, Ensure the safe operation of non-point of failure. In addition, the digital circuit breaker has its own unique characteristics, that is, on the basis of the intelligent microcontroller to establish the hardware system, with the keyboard and liquid crystal display can present to the user a more friendly interface interface and parameter setting platform. Because the intelligent microcontroller data has the advantages of high integration and strong processing ability, the software and hardware design of the system is very flexible, so that the digital circuit breaker can carry out accurate fault diagnosis, at the same time, the circuit breaker has the function of communication network, and is convenient to set and adjust all kinds of protective action parameters. The fault parameters of the protection circuit during operation can be stored in the non-volatile memory, so as to facilitate the later query and use. A large number of digital circuit breakers can form intelligent distribution system through interactive network, which has functions of remote control, telemetry, remote adjustment and remote communication. At the same time, it can also promote the protection of digital circuit breaker to network, intelligent and digital.

## 3. Common Faults of Digital Circuit Breakers

### 3.1 Signal Acquisition

First, touch the head to reject action. First, refuse to break. (1) The iron core is not started. Inducing factors: coil damage or partial wire break, coil terminal with voltage stuck iron core. (2) There is no action for the board. Inducing factor: the body or part of the mechanism is serious. Second, refuse to

close the switch. (1) The operating lever is not started after the iron core action. Inducing factors: close the lock QQ into the traction rod is too deep, the movement process is obstructed, iron core impact rod caused by deformation, coil terminal voltage is too low. (2) The iron core is not started. Inducing factors: coil damage, wire break or iron core stuck when there is voltage in the loop, fuse fuse when there is no voltage in the loop, or auxiliary switch contact can not contact normally. (3) The operating mechanism is not released. Inducing factors: traction rod is not out of the "dead zone", the lever appears distortion deformation, the operating mechanism or the main body is seriously stuck. Second, the wrong closing. The key factors affecting the power system in the digital circuit breaker are the misoperation of the circuit breaker itself, which causes the phenomenon of automatic closing, and then the opening, and the automatic closing after the energy storage. The abnormal phenomena and inducing factors are analyzed as follows :(1) automatic opening. The inducing factors include: grounding fault of secondary loop, relay contact in closed state for a long time, low action voltage of opening coil. (2) Coil is closed after storing energy. The inducing factors include: the force of the closing four-link is too small, the four-link is reset due to the deformation of the returning spring, the motor power is not converted in time, and the connection of the lock bracket is loose. (3) after opening and closing. The inducing factors include: the amplitude after the reset of the operating mechanism is too large, the latch is not reliable due to the serious deformation of the appearance of the lock hook, and the operating mechanism and the opening buckle are not completely reset. Third, relay failure. Relay is mainly composed of arc extinguishing system and power system two parts, through the contact open, close and make the circuit breaker in the process of running or disconnect the circuit. Good contact contact can ensure that the digital circuit breaker will not overheat when bearing the rated current, so as to maintain the stable operation of the whole system.

#### 4. Conclusion

On the one hand, run the check. The inspection items of digital circuit breaker mainly include :(1) whether the arc extinguishing gate is loose or damaged, whether the discharge sound caused by bad contact occurs; (2) whether the load current meets the rating requirements; (3) Whether the auxiliary contact is ablated; (4) Whether the pressure loss trip coil has abnormal sound or overheating; (5) Whether the signal running indicator conforms to the closing and dividing state of the circuit; (6) Whether there is overheating at the contact point of all parts.

On the other hand, operational maintenance. Maintenance items of the digital circuit breaker mainly include :(1) regularly clean the dust outside the device to ensure the insulation level of the digital circuit breaker; (2) Lubricating oil should be added regularly between rotating parts in operation; (3) after the short-circuit fault occurs, it should be timely detected whether the contact is in good contact, whether the arc extinguishing gate is seriously burned, whether the arc extinguishing wall is broken and so on; (4) in the purchase of new digital circuit breakers, should strictly check the integrity of the product, whether there is due to transportation or storage is not in place and lead to defects, exposed metal parts without rust phenomenon, if there is the above situation, the product can not be used, need to immediately contact the manufacturer, replace the new product.

#### 5. System Function Design

The automatic air circuit breaker on-line monitoring and diagnostic system is designed to have the following functions. Status monitoring: monitor the opening and closing state of the circuit breaker, identify the signal information with the model, extract the standard value of the model, and infer the corresponding scheme.

We take a typical failure type as an paradigm.(1) Data preservation: the low-voltage circuit breaker saves the current coil signal at any time according to the working time to serve the data.(2) Historical query: summarize and record the abnormal time and type of the low-voltage circuit breaker to ensure that the curve and status data can be called quickly.(3) Fault detection: the specific algorithm and type of the low-voltage circuit breaker fault are determined by the size of the collected motion

characteristics.(4) Communication alarm: When the operation track of the complete set of power distribution device is abnormal, the warning equipment is in the abnormal operation mode, and the red alarm button sends out the alarm noise as a reminder, and they should be vigilant.3.2 Components in the system The hardware and software parts in the system include the upper computer and the lower computer, wherein the upper computer is composed of a control board, a hard disk, and a display, capable of collecting operating system data and software.The main chip of the lower position machine is mainly FPGA chip, which is regarded as a key component of the system and plays an unusual role in data collection and communication.Logic board in the upper computer can connect some sensors, SSD and display, SSD to save a large number of state data, combined with the software running platform and man-machine interface, real-time monitoring circuit breaker status, need to extract data to read, in order to more intuitive observation, data and results will be displayed in the forefront, query previous data, health identification, fault detection and data preservation combination.The Hall current sensor collects current signals, contact actions, etc. in the lower position machine, and then transmits the data to the FPGA chip through A / D, and finally slices the circuit to avoid system faults and promote system stability.The lower position computer takes FPGA chip as the main working chip and adopts digital filtering algorithm to enhance the stability of the process in the data collection stage and make the process more smooth without fluctuation. In order to monitor the status of the automatic air circuit breaker in real time, the online monitoring and evaluation system has a high standard due to the amount of information and environmental uncertainty. Therefore, the file uses the FPGA chip as the main part of the data collection from the lower position computer.The adoption of FPGA chip is due to the following characteristics: (1) rich functions.Digital circuits can be adjusted as needed, less design restrictions, high flexibility.(2) Rapid response.The FPGA chip execution hardware is applied to ultra-fast electronic lines, which can improve the speed of the whole line, and run with a very fast logic. (3) short time, less cost, and low risk.(4) Super-fit.Ability to integrate the CPU to implement the system.

## 6. Conclusion

To sum up, digital circuit breaker plays a very important role in power system. However, the current digital circuit breaker in the operation process is prone to different faults, such as contact rejection, false closing, relay failure, seriously affect the stability of the system. Therefore, in the operation of digital circuit breaker, we should pay attention to the inspection and maintenance to ensure that it can operate safely and stably.

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## References

- [1] Bai Changyu, QIAN Kai, Han Guo-hui, Zhang Guo-yue, WANG Zheng-qi, DONG Hua-jun. Research on digital control technology of motor driving mechanism of high voltage circuit breaker [J]. Journal of dalian jiaotong university, 2020,41 (05) : 102-106.
- [2] Huang Yan zhu, Huang Huai push. Guangxi electric power, 2020,43 (03) : 71-73. (in Chinese).
- [3] Wu Wenming. Fault Handling and Maintenance of Low-Voltage Intelligent Circuit Breaker [J]. Electronics World, 2020 (09) : 158-159.