On-line Diagnosis Method of Power Electronics Fault Diagnosis

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Abstract. With the development of science and technology, the application of computer technology in electronic power fault diagnosis technology has become more and more extensive. This article mainly studies the detection methods of power electronics and the application of power electronics circuit fault diagnosis.

Keywords: Electronic Power, Fault Diagnosis Method, Application

1. Introduction
With the rapid development of science and technology, more and more people have begun to pay attention to diagnostic tests. Detecting electronic circuit faults is very different from analog faults and digital circuit faults. It is necessary to judge the fault type according to the output format. In the process of fault detection, we need to develop appropriate models and algorithms to control the faults in the circuit, so that we can accurately develop good results [1].

2. The principle of power electronic circuit failure
With the development of science and technology, in the fault detection of power electronics, sensors are used to collect the fault signals of the circuit system. At the same time, we can use the fault rate diagnosis algorithm to identify the fault signals, so that we can accurately determine whether the system circuit is faulty. In the calculation process, each error signal in the circuit system needs to be determined, and then the corresponding calculation model is established. We need to reflect each signal on the system. It is also necessary to measure the initial current and voltage of the circuit, as well as the overload capacity parameters of each device in the circuit. We also need to perform corresponding calculations according to the established model. This new type of diagnosis method has many advantages compared with the existing diagnosis method. In traditional power electronic systems, the overload capacity of power electronics is small and the damage rate is relatively fast. It is difficult to make very accurate predictions before failures occur. However, the traditional error detection method is based on frequency [2]. As a result, a slow-changing waveform can only be judged based on the waveform, and it is difficult to catch a sudden change in a sudden change. The brand-new sensing technology is updated on the original basis to reduce original errors, reduce missing circuit errors, and improve the accuracy of circuit diagnosis.

3. Detection methods of power electronics
There are mainly five detection methods for power electronic systems, as shown in Figure 1.

![Detection method of power electronic system](image)

**Figure 1.** Detection method of power electronic system

### 3.1. Spectral analysis detection method

In the fault detection of power electronic systems, the most important link is to extract the characteristics of the fault. Among these methods, spectrum analysis is a commonly used signal processing method. The signals measured daily include noise, which causes the corresponding interference when the fault signal is formed, this cannot accurately reflect the characteristics of the fault. The fault information contained in the power electronic circuit system has a certain periodicity. We can use the calculation formulas such as Fourier transform to change the fault waveform to the frequency domain. This can highlight the characteristics of the fault, analyze its characteristics, and make an accurate diagnosis. In addition, we can also use Walsh changes to decompose the function, filter it into a digital signal, and then perform corresponding processing and statistics. This method can directly use the observed data for analysis, and change some filter parameters through calculations, so that it can adapt to the performance of the filter and automatically track the characteristic changes of the signal. This method can not only cancel the noise according to the actual situation, enhance the spectrum, but also improve the accuracy of diagnosis [3, 4].

### 3.2. Application of parametric model

The installation of the parameter template is based on a large amount of data. The state and power circuit system parameters in the measurement are estimated with a small number of measurement points, each state variable and the variation range of the system parameters. The filter fixes the fault output direction of components, actuators and sensors in a certain direction or plane. At the same time, we can monitor the system through the detection system, and then analyze the changes of system parameters through state changes to diagnose the fault. In the state estimation process, we need to use an observer or filter to reconstruct the output to get an approximate value of its output, which can produce something different from the actual estimated value [5]. This difference can effectively reflect the changes in the internal information of the system, and then through the least square calculation method, errors can be detected accurately and quickly.
3.3. Pattern recognition detection method

After mastering a large amount of information through analysis, we use the information type identification method that reflects the characteristics of the defect to extract it, and then classify the defects according to the information characteristics and reflecting conditions. It does not require structure recognition to build a model in advance, but simulates and analyzes the mathematical characteristics of the sample. This method is very important for complex and difficult problems in the mathematical model. At the same time, this method has been widely used in industrial systems [6].

3.4. Online detection method based on neural network

The fault signal can be associated with the self-learning and self-induced fault classification of the neural network, and the corresponding error diagnosis can be performed. The neural network consists of an input layer, an intermediate layer and an output layer. It is a multi-layer network system that uses non-directional propagation. The middle layer is composed of several layers, and each layer receives the output of neurons in the previous layer, but this transmission process does not have a response coordination mechanism, and two-way coordination is impossible. When using this method, there is a difference between the actual output and the expected output. We can use this difference to adjust the corresponding neural network, which can reduce the error of the method [7]. When the electrical and electronic circuit system fails, the neural network will establish a relationship between the fault waveform and the cause of the fault, and then reflect this relationship by changing the current waveform or voltage waveform, and then analyze and diagnose it. The learning algorithm of BP neural network is shown in formula (1), the backward error propagation algorithm of BP neural network is shown in formula (2), and the structure of BP network model is shown in Figure 2.

\[ y_{ip}^k = f^k[net_{ip}^k] = f^k[\sum_j W_{ij}^k(n)y_{ip}^{k-1} + b_i^k(n)] \]  
\[ E_p(n) = \frac{1}{2} \left\| T_p - y_p^k(n) \right\|_2^2 = \frac{1}{2} \sum_m [d_{mp} - y_{mp}^k(n)]^2 = \frac{1}{2} \sum_m e_{mp}^2(n) \]  

\[ \text{Figure 2. BP network model structure} \]

3.5. Detection method of wavelet transform
When an electronic circuit system fails, each sudden change signal corresponds to a corresponding error. By analyzing the various waveforms and signal frequency bands generated by these errors, it is not only possible to determine the operating status of the system components, but also an efficient fault detection method. Generally, the signal of a normally operating circuit system is stable, but the signal of a faulty circuit system has a certain degree of variability. The wavelet transform method can perform local analysis on these non-static signals, and analyze them quickly and accurately. It provides a powerful tool for effectively identifying fault signals and diagnosing China's power electronic circuit systems [8].

4. Reliability analysis of fault diagnosis
Fault diagnosis reliability analysis refers to the detection of various faults in each device unit of the product during the design and manufacturing process of the product, analysis of its impact on the product function, elimination and improvement of potential faults, which effectively improves the reliability of the product. Analysis objectives include failure mode analysis, failure cause analysis, failure impact analysis and failure detection method analysis. Among them, mode analysis refers to strict product testing, functional analysis, production materials, production processes, production equipment, etc. Troubleshooting of possible failure modes in various details. Cause analysis refers to determining the cause of a failure during operation and solving the problem. Impact analysis involves analyzing each barrier type, and then ranking the impact of each barrier based on its severity and results. The analysis of the failure detection method is to see if there is a specific method that can detect the failure mode after multiple actual work [9]. Once detected, the corrective actions corresponding to the specific conditions of each fault will be highlighted, which can form the basis for future fault detection and isolation designs.

5. Application of power electronic fault diagnosis
In the past diagnosis process, many real data sources and knowledge bases have been accumulated to explain the cause of the failure. First of all, it may be caused by the lack of driving signals on the grid of the power tube or poor welding of the grid pins. The main reason for this situation is insufficient power supply or insufficient protection voltage. Secondly, it may be caused by poor power supply of the motor or short circuit of the power supply. The reason for this situation is that the switch cannot be controlled, which causes the two tubes of the same bridge arm to pass through. In addition, the connection between the inverter and the motor's three-phase bus interface is unstable or the load is asymmetrical, and the waveform observed at this time will appear abnormal, which can easily affect the fault detection. There are different types of current waveforms in the current waveforms detected during the operation of the power electronic system, and different signals or parameters can be used to reflect the fault characteristics of the system. These information and data form a comprehensive and mature information base. Assisting the development of future inspection tasks can also help to determine the fault link and solve the difficult problems encountered [10].

6. Conclusion
With the development of science and technology, there are more and more fault detection methods in power electronic systems, and the detection technology is getting higher and higher. This article introduces several commonly used fault detection methods. The relevant personnel should be based on the actual situation, and then we must combine the above methods to accurately determine the defects, make these methods more reasonable and feasible, and then provide more value to people.

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