On Transformer Automatic Detection Technology in Power System

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Abstract: Firstly, in this paper, the purpose and significance of power transformer research are explained and the research background is analyzed. Then, the functional characteristics and system structure of transformer automatic detection device are summarized. Finally, the working principle of automatic detection device in power system is discussed, which has important practical significance for the safe operation of power grid.

1. Introduction

At present, PLC industrial control computer has good versatility and strong anti-interference performance, so it is suitable for power transformer automatic detection system, which will enhance the communication ability of the system. So it can be seen that it is suitable for long-distance communication with few lines, convenient maintenance, high accuracy, strong anti-interference ability, low price and wide application range, meeting the requirements of real-time measurement and control.

2. Purpose and Significance of Research

Nowadays, the power sector regularly carries out preventive tests on power transformer outages. In addition, if abnormal symptoms are found in the test cycle, it is necessary to carry out off-line detection. This regulation prevents transformer from serious accidents and ensure its reliability and safety. However, some problems have been found in the long-term practical work. There are some limitations in the above methods.

2.1 Economic Aspect

Regular tests and repairs can only be carried out in the state of power outage. Therefore, in this very precious period of time, if the power transformer can be repaired in multiple states, it will reduce a lot of economic losses.

2.2 Technology

There are many inconvenience factors in general overhaul. The connection types of single test room are different, requiring testers to debug before each test, which greatly reduces the work efficiency, cause measurement errors and lead to lower accuracy. The software of automatic detection device system has the function of test database, which can save and compare the data in the test, so as to improve the efficiency of overhaul, realize the rapid layout of the device, and make it enter the working state as soon as possible.

3. Research Background

Transformer is the main component of power system. Whether the power grid is safe or not, transformer is the key. As an integral part of transformer routine test, DC resistance test is an indispensable test item, and also a part that needs to be checked after faults occur.

Power transformer is related to the level of security and stability of power grid, so its operation and service life are related to the development of power grid. With the aggravation of power supply task and the continuous expansion of scale, the demand for power equipment is also increasing.

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Therefore, the application of automatic detection devices fully conforms to the development trend of today's power grid. The traditional detection method of power transformer is to transport equipment manually to the substation site, then carry out individual tests one by one, record the data of each test, consult all the paper reports in the data cabinet, then calculate and analyze, and finally issue the test report. This traditional test mode formed over the years fail to meet the needs of the current power grid development, which is embodied in the following. It is unable to effectively carry out standardized electrical test. It has a low security of test personnel and equipment with high labor intensity of test work. It is in a low depth of data analysis with large workload of later stage of test data processing.

The automatic detection device in this paper adopts a complete set of integrated control management mode, including PC control, loop resistance measuring instrument control, high voltage dielectric loss factor measuring instrument control, automatic switching switch part control and control of equipment components involved in data management system. In power system, the device can provide a more perfect test system for transformer state test, and greatly improve the efficiency of users.

4. Basic Overview of Transformer Automatic Detection

The device integrates the detection functions of dielectric loss, insulation resistance, DC resistance, switching characteristics of tap changer, short circuit impedance and change of power transformer, realizes one wiring, one operation, and the system automatically completes all or part of the above test items.

4.1 Functional Characteristics of Automatic Detection Device

The function features of automatic detection devices are high efficiency, high precision, test configuration, good safety performance and so on. Efficiency means that when testing is needed, only one preparation can complete the whole operation, and the efficiency is greatly improved. High precision means that the automatic detection device itself is equipped with high precision detection instruments, and the accuracy of results is higher than that of general detection equipment. Test configuration means that transformer can be tested with different schemes under specific conditions, and the safety performance is good. The device also improves the safety factor in the operation process and eliminates various risk factors.

4.2 System Structure of Automatic Detection Device

The device is mainly composed of the following parts:

(1) Centralized control unit: It realize the control and management of the device and is mainly composed of a computer and software of the detection system.

(2) Power supply unit: To provide working power for the normal operation of the device.

(3) Host unit: the detection part of each location.

(4) Switching unit: When detecting, switch between low, high and low voltage.

5. Working Principle of Automatic Detection Device in Power System

In the process of test, in view of the problem that the dielectric loss factor and insulation resistance of power transformer need to be disconnected many times, on the basis of digital measurement, the high voltage detection unit of this device has added the function of automatic detection on the premise that the connection is needed when the test is started, so that various kinds of transformer can be automatically measured in the process of work. It is important to note that no disconnection is required during the test.

In this paper, we take three-winding transformer as an example. The centralized control unit carries out unified control and management of each module, so that it can cooperate with and realize automatic measurement in the process of transformer operation.

(1) Measurement of dielectric loss factor. In the switching unit, the switching switch is turn to

the reverse connection measurement part of dielectric loss factor. The AC high voltage is input at the high voltage interface. The high voltage relay 1 is switched to the high voltage terminal, and the high voltage relay 2 and 3 are switched to the ground terminal. The dielectric loss values of high voltage to the medium voltage, the low voltage and the transformer housing are measured. The low-voltage measuring line of the dielectric loss measurement part is connected to the end screen of the transformer winding bushing. Finally, the dielectric loss value of the high-voltage side winding bushing is measured.

(2) Insulation resistance test. Switch the switch to the insulation resistance measurement part, input DC high voltage at the high voltage interface, switch the high voltage relay 1, 2, 3 to the ground end part, continue to discharge to the ground for 2 minutes, switch the high voltage relay 1 to the high voltage end, switch the high voltage relay 2 and 3 to the ground end, and measure the high voltage side winding and medium voltage, low voltage and transformer in the insulation resistance measurement part as well as the value of insulation resistance between the enclosures. Before using the automatic detection device to test, we should first judge the attributes of transformer, and secondly judge the content of the test, including transformer winding and bushing, transformer winding, transformer bushing. Here, we take the measurement of dielectric loss factor and insulation resistance of three-winding transformer and measuring transformer winding and bushing as examples.

6. Relevant Design of Automatic Detection of Power Transformer

When testing the parameters of power transformers in China, most of them still use manual operation and manual reading method. Although some enterprises have used the computer testing system for power transformer parameters, because the equipment used in these systems is relatively backward, the project of system testing is relatively single and the automation of testing is not high. In recent years, with the development of computer technology, there are some power transformer parameter testing systems with complete functions, but the price is high, which can not meet the needs of some enterprises. Therefore, in order to meet the current demand for power transformer parameter testing, it is of practical significance to research and design a set of power transformer parameter automatic testing system with high precision, high automation and low price. On the basis of the previous research on power transformer parameter testing system, and in combination with the current power testing technology, computer network technology and automation control technology, a set of overall design scheme of power transformer parameter testing system with high degree of automation, is put forward. The system can measure the parameters of the transformer automatically or manually, and the parameters of transformer, such as three-phase voltage, three-phase current, active power, reactive power, power factor, frequency and temperature of the oil top.

6.1 Hardware Composition of the System

The whole system consists of computer, printer, network connection card, programmable controller PLC, power parameter monitoring unit, temperature acquisition unit, frequency conversion drive unit, voltage regulator motor, transformer set, intermediate transformer, electric switch and other equipment.

6.2 System Control Unit

In this system, the C200Ha series programmable controllers of OMRON Company of Japan are selected as the control equipment of field equipment. Its main functions are as follows. In the process of parameter testing of power transformer, the switching control of voltage and current transformer ranges can be realized to meet the requirements of power parameter monitoring unit for acquisition signal amplitude. It also monitors the condition of test power supply. According to the three-phase voltage and three-phase current input from analog I/O unit, the feedback output controls the voltage-regulating motor driven by the frequency converter to realize the automatic control of the voltage-regulating process. Under the manual operation mode, the control of the testing process

can be realized. Before using PLC, the first thing to do is to set up PLC, that is, to build the PLC system with some basic hardware units and special hardware units. The basic units include power supply unit, standard I/O unit, CPU unit, communication board, memory unit, floor and frame, etc. The special units include high-speed counting unit, position control unit, analog I/O unit, temperature detection control unit, loop control unit, etc. Special elements are optional.

6.3 Temperature Measurement

According to GB 1094.2-1996 and JB/T 501-91, the temperature of transformer oil top layer should be measured by thermometer with accuracy not less than 0.5 C in temperature rise test. The temperature measurement system is composed of LTM 8201 intelligent temperature measurement module and matching temperature sensor of Beijing Changying Science and Technology Co., Ltd. instead of using thermometer to measure the temperature of oil top layer, which meets the accuracy requirements of the system. The main function of the temperature acquisition module is to measure and collect the temperature of the top oil layer and the surrounding environment of the power transformer during the temperature rise test. The copper tube encapsulated temperature sensor probe LTM8873 is used to measure the top oil temperature of the tested power transformer, and the wall encapsulated temperature sensor LTM8872 is used to measure the environmental temperature of the tested power transformer. After the temperature rise test, the measured data can be transmitted to the host computer through the RS-485 communication interface COM3 of the network connection card MOXA CP-132. In addition, the module also has alarm function when the temperature at a point on the top of the oil layer exceeds or falls below the set temperature upper limit.

7. Conclusion

With the rapid development of China’s electric power industry, the scale of the power grid continues to expand, the capacity and installation capacity of the power transformer continue to increase, and the voltage level is also constantly improving. It is of great practical significance to strengthen the research on automatic detection technology of power transformer to ensure the safe operation of power grid.

References

[1] Xu Hongping. Transformer Automatic Detection Technology in Power System [J]. Communication Power Supply Technology, 2018,35(12): 46-47+61.

[2] Xin Mingyong, Xiao Xiaobing, Liu Bin, Lin Chenghui, Xiong Jinmei, Yuan Xi and Su Gongchuang. Transformer Respirator Automatic Detection Based on Image Processing [J]. Mathematical Practice and Understanding, 2018, 48 (02): 127-133.

[3] Guo Jian, Ren Beiting, Xiang Guanteng, Zhang Jianbing and Wang Shaokun. Research on Automatic Detection and Analysis system of Transformer Insulation Oil Purification Device [J]. Electrical Switch, 2016, 54 (01): 21-25.

[4] Chen Weiqiang. Research on Transformer Automatic Detection Technology in Power System [J]. Mechatronics Information, 2014 (33): 111-112.

[5] Fu Bin, Li Huazhang. Automatic Detection of Transformer Connection Groups Based on Single Chip Microcomputer [J]. Industrial Control Computer, 2014, 27 (01): 128-129.

[6] Liu Jian, Jiechen, Lin Lihua. Automatic Oil Level Detection Method of Power Transformer Based on Infrared Image [J]. High Voltage Technology, 2010, 36 (04): 964-970.

[7] Chen Yueming. Application of 89C51 in Automatic Detection and Control of Transformer Temperature [J]. Journal of Nanchang University (Science Edition), 1998 (03): 52-56.

[8] Li Qi. Application of Differential Transformer in Automatic Detection Technology [J]. Journal of Hebei Institute of Mining and Metallurgy, 1980 (02): 46-52.