Design and Research of 10KV Electronic Transformer Live Performance Evaluation Platform

Yongchao Wang¹, Wei Zhang¹, Na Li¹, Jiahai Zhang², Guixian Wang², Linhao Su² and Xinhang Gao²

¹Electric Power Research Institute of State Grid XinJiang Electric Power Company, Wulumuqi, Xinjiang, China
²Yantai Dongfang Wisdom Electric Co., Ltd, Yantai, Shandong, China

Abstract. Design and research a test platform suitable for 10KV electronic voltage transformer and 10KV electronic current transformer for long-term charging performance evaluation. The 10KV electronic transformer live test platform includes a primary boost device, a primary current boost device, a reference voltage transformer, a reference current transformer, a standard voltage transformer and a standard current transformer. The test circuit is designed to be three-phase. Under the condition that the system input voltage is 380V / 220V and the total input capacity is not greater than 100KVA, the auxiliary transformer and other auxiliary equipment are used to achieve long-term live operation and performance evaluation of the 10KV electronic transformer.

1. Introduction
With the rapid development of optical fiber sensing technology and optical fiber communication technology, the application of optoelectronic technology in power systems is becoming more and more widespread, and electronic transformers are one of them. Electronic transformers have many advantages such as small size, light weight, wide frequency band response, no saturation phenomenon, good anti-electromagnetic interference performance, no oily structure, reliable insulation, easy development to digitalization, and computerization. The birth of electronic transformers is an inevitable result of the development trend of accurate transformer sensing, transmission fiberization, and digital output. Electronic transformers are one of the key equipment of digital substations.

In actual operation, there are some problems with electronic transformers because of the complicated on-site environment and many interference sources. The interface compatibility of conventional current transformers does not have a unified output interface, and the product standards have not been standardized. Frequency response, dynamic range, signal-to-noise ratio, waveform distortion, and stability inspection require special specifications. Calibration problems. The output is a weak electrical signal and includes digital quantities. New calibration methods must be explored. Equipment reliability issues, including electromagnetic compatibility, system thermal stability, and reliability issues of electronic components need to be further examined in engineering applications.

Design a 10KV electronic transformer live test platform detection system to simulate the reliability analysis and operational data analysis of electronic transformers under long-term operation under normal and fault conditions in actual engineering and promote the digital electronic transformers in Wide application in smart grid.
2. 10KV Electronic Transformer Live Performance Evaluation Platform Principle

In the field operation detection system of measuring equipment, the operating data of traditional electromagnetic transformers and electronic transformers are compared, and regularly calibrated with indoor standard transformers to evaluate the traditional transformers and electronic transformers during long-term operation. Accuracy and stability. Analyze the influence characteristics of the transformer error and the environment such as temperature, humidity, and air pressure, and lay the foundation for evaluating the measurement performance under the typical environment of the transformer. The schematic diagram of the 10KV electronic transformer live performance evaluation platform is shown in Figure 1.

Figure 1. 10KV Electronic Transformer Live Performance Evaluation Platform Principle Diagram.

The 10KV electronic transformer's live performance assessment platform equipment mainly includes: a three-voltage control box (cabinet) and three high-voltage current transformers to form an up-current system; three voltage-regulation control boxes (cabinet) and three test transformers Voltage system; three standard voltage transformers and standard current transformers form a standard unit; three reference voltage transformers and current transformers form a long-term reference standard unit; auxiliary connection equipment such as high-voltage switches, circuit breakers, arresters, installation Base, connection bronze medal, etc. control device, used for control of test status and control of voltage and current rise and fall.

3. 10KV Electronic Transformer Live Performance Evaluation Platform Configuration

The primary voltage part of the performance evaluation platform for electronic transformers includes three voltage regulator boxes, three boosters, and the primary current part includes three voltage regulator control boxes and three high-voltage current boosters. The voltage part is composed of a 5kVA voltage regulator and a 12kV / 5kVA booster, which provides a variable voltage of 0-12kV. The purpose of changing the primary circuit test voltage can be achieved by changing the output voltage of the voltage regulator. The current part consists of a 20kVA voltage regulator and a 500A / 20V high-voltage upconverter, which provides a "virtual power" current of 0 to 500A. The purpose of changing the primary circuit test current can be achieved by changing the output voltage of the voltage regulator. The schematic diagram of the power supply of the electronic transformer performance assessment platform system is shown in Figure 2.
The standard measurement section includes three standard voltage transformers, three standard current transformers, high-voltage disconnectors and circuit breakers.

The standard voltage transformer is connected in parallel with a test circuit through a high-voltage isolation switch. When an error calibration of the electronic voltage transformer or the reference voltage transformer is required, the standard voltage transformer is connected to the system by closing the switch. In the daily running state, the standard voltage transformer is removed from the system by disconnecting the switch. The standard voltage transformer is 42KV insulated and cannot be used for a long time.

Standard current transformers are connected in series in the test circuit through two high-voltage isolation switches and a circuit breaker connection. Because there is a large current in the virtual power circuit, when the standard current transformer is switched on or off the system, a circuit breaker is required for the load. Switching, standard current transformer is also used for error calibration of the tested electronic current transformer or reference current transformer. Its insulation is 42KV and it cannot work for a long time.

The reference standard includes three voltage transformers, three current transformers, high-voltage disconnectors and circuit breakers.

The reference standard voltage transformer is connected in parallel in a test circuit. Its insulation is designed according to 42kV. It can work for a long time under power. It can compare the error data with the tested electronic voltage transformer in real time. Error status.

The reference current transformer is connected in series in the "virtual power" test circuit. Its insulation is designed according to 42kV. The primary conductor is connected by a copper busbar. Monitor the error status of the electronic current transformer under long-term live operation.

The control part includes the control device of the test state and the upgrade control of the voltage and current. Auxiliary equipment includes lightning arresters, mounting bases, and connecting busbars. The cross-sectional view of the cable trench of the 10KV electronic transformer live performance assessment platform equipment is shown in Figures 3 and 4.
In order to ensure that the complete set of equipment is suitable for long-term outdoor operation, reference standards, boosters, and current boosters are designed for long-term outdoor operation. Isolator switches and circuit breakers are designed with outdoor electrical equipment specifications to ensure safe and reliable operation of the equipment.

4. Application Method of 10KV Electronic Transformer Live Performance Evaluation Platform
The evaluation platform can evaluate the performance of the electronic transformers under long-term live working, the long-term error comparison data of the electronic transformers, and the effects of the system voltage and current shock on the electronic transformers and the error calibration during the long-term operation of the electronic transformers. The platform is divided into three phases for evaluation, and the three-phase equipment and control methods are the same. Analyze the operating status of the electronic transformer based on the schematic diagram of the 10KV electronic transformer live performance assessment platform (Figure 1).

4.1. Long-term running status of electronic transformer
Switching status: QS1 closes → QF1 closes → QF2 points → QS2 points → QS3 points; at this time, only the reference voltage transformer, the tested electronic voltage transformer, the reference current
transformer and the tested electronic current transformer are connected to the system, While the standard voltage transformer and standard current transformer are not switched into the system. In this way, the electronic transformer can be operated with electricity for a long time, and the real-time error data can be compared with the reference transformer.

4.2. Error calibration status of electronic transformer
Switch status: QS1 closes → QF1 points → QF2 closes → QS2 closes → QS3 closes; at this time, the circuit breaker QF1 can be separated first, then QS2 and QF2 are closed in sequence, and a standard current transformer is connected in series to the test circuit; Then close QS3 and connect the standard voltage transformer in parallel to the test circuit. In this state, the error data of the electronic voltage transformer and current transformer after long-term live operation can be measured at the same time to verify the error status. The switching sequence for exiting the error state is: QF1 on → QF2 points → QS2 points → QS3 points.

4.3. Pulse voltage and current test status of electronic transformer
Switch status: QS1 closes → QF1 closes → QS2 minutes → QF2 minutes → QS3 minutes; in this state, controls QS1 closes → points → closes, connects high voltage → exit → access ...; QF1 closes → points → closes, Connect high current → exit → access..., both are performed simultaneously. At this time, based on the state 1, control the isolating switch QS1 to be continuously opened and closed to continuously connect and disconnect the high voltage from the primary circuit of the booster; control the circuit breaker QF1 to be continuously opened and closed to continuously connect and disconnect the high current circuit; The two are carried out at the same time to verify the shock resistance of the electronic transformer under high voltage and current conditions. When in use, the control mechanism and sequence of QF2 and QS2 are as follows: the switching state is QS2 first, then QF2; the off state is QF2, then QS2. The above sequence must not be wrong, otherwise the disconnector will cut off a large load, arcing of the switch or even damage the switch will cause a safety accident.

5. Conclusion
10KV electronic transformer live test platform detection equipment and its use method are used to simulate the reliability analysis, service life prediction, continuous operation data analysis and electromagnetic compatibility of electronic transformer under long-term operation under normal and fault conditions in actual engineering Aspects of work; to ensure the reliability of electronic transformers in actual engineering operation, and to promote the widespread application of digital electronic transformers in smart grids.

Acknowledgments
This work was financially supported by the fund of Research on Reliability Technology of Stress Superposition Effect of Smart Energy Meter Based on Typical Environment (Project Code: 5230HQ19000F).

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