Research on live detection technology of Arrester Based on wireless synchronization technology

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Abstract. There are a lot of MOA in power system, and it’s reliability is very important to power system. In order to ensure the safe operation of MOA, the running state of MOA must be tested regularly. This paper studies the traditional method of live detection of arrester used in substation. Based on the principle of live detection of wired arrester, a new method of measuring Arrester Based on wireless synchronization technology is designed. It provides a new measuring method for the live detection technology of lightning arrester in substation, and detects the aging and damp of arrester more efficiently and safely.

1. Introduction
One of the main reasons for the failure of arrester is the aging and damp of internal resistor. At present, the method of measuring the full current and resistive current is mainly used to judge the operation state of arrester. However, the measurement of resistive current requires high accuracy of the instrument, so shielding test cable is often used to introduce the voltage and leakage current signal of arrester to the instrument host for measurement and calculation. This method has been verified for many years and is effective[1]. However, if the CVT (PT) or 220 V AC power supply test line of the system is led out for a long enough distance, sometimes as long as tens of meters, it is easy to be disturbed by electromagnetic field, resulting in inaccurate data measurement. In addition, in the early stage of the test, a large number of test cables need to be connected, which affects the test efficiency and brings great inconvenience to the testers[2-5]. In order to solve the problems in the field application of the arrester live resistance current tester, this paper studies the live resistance current measurement technology based on wireless synchronization technology.

2. Three phase synchronous live line detection method of 1 arrester

2.1 measurement principle
This paper presents a method of live monitoring of arrester by wireless way. Three current acquisition units are used to obtain the discrete sampling data of three-phase current of the arrester, and one voltage acquisition unit is used to obtain the discrete sampling data of one phase voltage of the corresponding three-phase arrester. The acquisition unit and the control unit output instructions and data through wireless[6-8]. After data collection, the host computer analyzes and calculates the data.

In this paper, based on the research of live detection method of arrester, a live monitoring device for arrester is developed, which can monitor the full current, resistive current, power and other functions of arrester. The overall design block diagram is shown in Figure 1.
Considering the large interference in the field environment, especially the interference of the third, fifth and seventh harmonics in the system, the harmonic analysis method is selected for signal processing in this measurement method. The full current signal of the arrester is sampled on site, and then the amplitude and phase of the current signal are calculated.

2.2 Wireless synchronous measurement algorithm
In this paper, the harmonic analysis method is used to extract the total current and resistive current, and the sampling all phase calculation method is used to measure the resistive current trend of arrester. The all phase calculation method is to add convolution on the basis of harmonic analysis method, which can effectively avoid the harmonic interference and frequency change of power grid. The principle of all phase analysis method is as follows: Suppose that the discrete sequence of the original signal is \( x(n) \), and the input data is \{..., \( X(-N+1) \),..., \( X(0) \),..., \( X(n-1) \),...\}. If all segments are considered, the following segments \( x_0 \sim XN-1 \) can be formed:
\[
\begin{align*}
  x_0 &: x(0), \ldots, x(N-2), x(N-1) \\
  x_1 &: x(-1), x(0), \ldots, x(N-3), x(N-2)
\end{align*}
\]

3. Development of wireless measuring device

3.1. Current detection scheme
The current detection scheme is to design a wireless sensor with a current clamp, which is directly clamped at the upper and lower ends of the arrester counter to completely introduce the current signal into the sensor. The sensor circuit mainly includes: protection circuit, I / V conversion circuit, RF suppression circuit, amplification circuit and low-pass filter circuit. The principle is shown in Figure 2:

![Figure 2. Schematic diagram of analog acquisition unit.](image)
3.2. Reference voltage detection scheme

The circuit of voltage detection scheme mainly includes: protection circuit, voltage dividing circuit, RF suppression circuit, amplification circuit and low-pass filter circuit. The principle is shown in Figure 3.

![Schematic diagram of analog acquisition unit.](image)

4. Software design

STM32F103 is an arm Cortex-M core specially designed for high-performance, The software program is as follows:

![Flow chart of measurement process](image)

5. Comparative analysis of test data

The data comparison between wired and wireless measurement methods of Liaoning Electric Power Company Wanghai 66kV arrester is as follows:
Table 1 Comparative analysis of test data

|                | Wireless measurement          | Wired survey               |
|----------------|-------------------------------|----------------------------|
|                | Ixa 0.5718                    | Ux 60.330                  |
|                | Ixb 0.5543                    | U3 0.040                   |
|                | Ixc 0.5805                    | △$\phi_a$ 84.5273          |
|                | Ira1 0.0765                   | △$\phi_b$ 86.8214          |
|                | Irb1 0.0434                   | △$\phi_c$ 88.0035          |
|                | Irc1 0.0284                   | Ira5 0.0015                |
|                | Ira3 0.0019                   | Irb5 0.0003                |
|                | Irb3 0.0009                   | Irc5 0.0005                |
|                | Ira7 0.0020                   | Ira7 0.0010                |
|                | Irb7 0.0003                   | Irc7 0.0001                |
|                | Ic1ap 0.8050                  | Ic1bp 0.7830               |
|                | Ir1ap 0.0765                  | Ir1bp 0.0434               |
|                | U1 60.320                     | △$\phi_a$ 84.5270          |
|                | △$\phi_b$ 86.8215             | △$\phi_c$ 88.0040          |

By comparing the measured data, the difference between wired and wireless measuring instruments is 2‰, which meets the accuracy requirements of live detection data of arrester.

6. Conclusion
In this paper, based on the wireless synchronization technology, the research on the live measurement method of the arrester can provide better test methods and tools for the live detection of the arrester. The live detection technology based on wireless mode can remove the test line between the live detection instrument and the test object, reduce the workload of retracting and setting out, make the field test more flexible, and ensure personal safety. Through the waveform and data displayed by the software, it is convenient for the test personnel to accurately analyze the operation state of the arrester.

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