

## Transmission Line Parameters Live Measuring Technology

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**Abstract.** With working frequency voltage and current, mutual inductance voltage up to 30kV and mutual inductance current up to 50A, measuring instruments can not offset mutual inductance voltage and mutual inductance current interference. The current test mutual inductance parameter must be the same poles of two lines powering outage at the same time. To solve this technical problem, development of transmission lines mutual inductance parameter live testing device, using the device can be achieved under the condition with the tower and rack (or parallel) lines of other circuits running live tests mutual inductance parameters. And expounds the hazards of mutual inductance parameters in the grid and discusses the theoretical basis of the live test equipment and major components.

### Introduction

With the development of the power system, the line corridor contains more and more mutual inductance line. For the same tower and rack (or parallel) of a three-phase transmission line, either loop once occurs zero-sequence current it cause a certain amount of alternating magnetic flux abounding, the magnetic coupling causes rack (or parallel ) the second loop is induced voltage. The coefficient of two loops interact each other referred their mutual, and the value with the length of the carrier (or parallel) increasing to increase the, with decreasing distance between the circuit increases[1].

Using traditional measurement methods must be the same poles of two lines at the same time power to measure mutual inductance parameters. However, in practice, to implement power running line is very difficult, if not power, based on the current level of the test will not be able to complete the mutual inductance parameters testing, because the existing measurement instrument used is frequency voltage and current, when on the same frequency power measurements, mutual inductance voltage up to 30kV, mutual inductance current up to 50A, measuring instruments can not offset the mutual interference voltage and current mutual inductance, thereby affecting the accuracy of measurement may not be measured, even perhaps damage to the measuring instrument. To solve this technical problem, development of transmission lines mutual inductance parameter live testing device, using the device can be achieved under the condition with the tower and rack (or parallel) lines of other circuits running live tests mutual inductance parameters[2, 3].

### The importance of mutual inductance parameters test

Mutual inductance parameters hazards on the grid are the following: Since the mutual inductance voltage generating excessive negative sequence current, when the negative sequence current exceeds 5% of the positive sequence current, it will cause the transformer, Motors and other equipment are from overheating in the system.

When the zero-sequence current exceeds a certain value, in the neutral point ungrounded system, certain sensitive protection devices may malfunction.

If adjacent lines occurs a ground fault, because the zero sequence mutual impact of line longitudinal zero sequence direction protection disoperation.

Effect of reactive power compensation configuration causes system power factor miscalculation.

When there is the same tower and rack (or parallel) line maintenance, mutual inductance voltage will cause injury, severe cases can lead to death.

Therefore, in order to obtain the true mutual inductance parameter to provide accurate protection setting data to ensure power system security, network protection regulations State regulations for new 66kV and above transmission lines, zero-sequence and mutual inductance parameter must be found.

### **Off line test mutual parameters theory**

#### **(1) Mutual parameters test theory**

In one line leads to a certain amount of alternating current around the wire be associated a certain amount of alternating magnetic flux immediately, so that exposure to the magnetic field induces a certain value voltage of another line, that the induced voltage. The induced voltage can be measured by the instrument. If the AC current is used in different frequency, (different frequency is not sinusoidal of 50HZ frequency) can overcome a powerful amount of interference frequency AC line operation carried around.

#### **(2) The basic principle of inter-frequency measurement**

In line measuring input terminal is different from the power frequency of 50 Hz test power in the frequency domain directly isolated frequency interference signals and useful-frequency test signals, aim to eliminate frequency interference effects. When measuring, the first measuring device to the measuring line interference on the line frequency and amplitude, to determine the maximum amplitude of frequency interference; then set the test frequency (40 ~ 60Hz), through variable frequency power supply to generated the measuring the voltage of setting frequency to the line under test; the last signal acquisition and analog and digital filtering, after Fourier transform can be obtained different frequency parameters obtained after conversion of 50 Hz power frequency parameters[4, 5].

### **Mutual inductance parameter measuring technology**

#### **(1) Development of power-frequency power supply**

Development of power-frequency power supply, under power frequency interference (electrostatic induction voltage 20kV, electromagnetic zero-sequence induction current 50A) to continue its normal output-frequency (45Hz) 50A test current, ensure waveform distortion less than 1%, a frequency output steady of less than 0.2%.

#### **(2) Development Rogowski coil**

Development of special Rogowski coil-frequency current measuring(resolution up to 10mA), precision 1%; RC-frequency voltage divider measurement (resolution up to 0.01V), accuracy of 1%.

#### **(3) Development of GPRS communications circuit to synchronize time**

Study GPRS communication to synchronize communications, ensure Rogowski coil and resistive and capacitive voltage dividers measure different phase error signals and test current is less than 1 degree.

### **Test the mutual inductance parameters of the device technical indicators**

Testing equipment main technical indicators:

(1) Test equipment inside the power-frequency power supply, the amount of frequency interference (electrostatic induction voltage 20kV, electromagnetic zero-sequence induction current 50A) to continue its normal output-frequency (45Hz) 50A test current, ensure waveform distortion in 1 %, the output frequency stability of 0.2% or less, in the range of 40-300HZ can be arbitrarily selected frequency, it is selected discrete <0.1% frequency measurement data, the total content of the non-selected frequency <0.5%.

(2) Ensure that the set of measurement apparatus to work in the amount of frequency

interference (electrostatic induction voltage 20kV, electromagnetic zero-sequence induction current 50A), the amount of interference with a detectable amount of 20: 1 under conditions of different frequency measuring accuracy no less than 0.5 %.

(3) Measuring device measuring Rogowski coil-frequency current (resolution up to 10mA), accuracy of 0.5%; RC-frequency voltage divider measurement (resolution up to 0.01V), precision of 0.5%;

(4) The measuring device is synchronized when GPRS communication communications, time accuracy within 50nS, ensure the phase error Rogowski coil and resistive and capacitive voltage dividers measure different frequency signal and test current is less than 1 degree.

(5) The measuring device is not lower than the level of insulation withstand 3000V.

Note: One end of the line is not charged directly to ground, and the other end to ground through the test device of a current loop and take the isolation and double over-voltage protection; running line sampling also matching the isolation and double over voltage protection.

### On line mutual inductance parameter measuring methods

Neutral to run the line at both ends of the connection of 220kV transformer windings are at the ground state as an example.

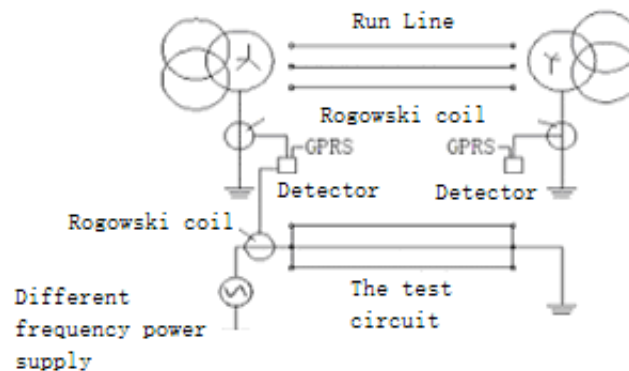


Figure 1 The test connection

First, test connection, as shown in Figure 1.

Second, under conditions of complete security measures, did not live to complete the test wiring line and testing equipment, ready to apply zero-sequence to be tested no live line different frequency current;

Third, in the conditions of safety measures completely, neutral running line connected at both ends of the high voltage winding of the transformer bushing ground deflectors into terminating the Rogowski coil and connected to the test device;

Fourth, the test device input run line related technical parameters (including operational line voltage supplying current transformer impedance parameters, line impedance parameters, etc.);

Fifth, check the uncharged grounding line inspection test device to ground confirm both good, demoliting affect output test equipment and temporary grounding wire input;

Sixth, to not live line filled with a predetermined amount (including the current frequency and size) of different frequency excitation current;

Seventh, the test apparatus according to the mutual inductance value of zero Different frequency current is applied and Rogowski coil current measurement taken automatically calculate these two lines of sequence.

### Conclusion

March 2014 device is applied to the State grid power company in Fushun, good application effect. Achieve mutual inductance between the live test run two lines, in order to ensure the adjustment line load imbalance and transmission voltage asymmetry provide real basis, improve

power quality. The technology and equipment in the country's power system can be applied, and the formation of industry standards, must solve the power outage when EHV transmission lines mutual inductance parameter measurement problems, with great economic and social benefits.

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