The Simulation Research in Active Grounding Protection of the Small Current Grounding System Based on Active Protection

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Abstract. The small current grounding system has many problems: low ability of extinguishing arc grounding and personal sense of electric system, none security and protection ability to indirect grounding overvoltage, equipment internal fault grounding. Especially with the rapid development of urban distribution network construction, the cable line users increasing, causing the system of single-phase grounding capacitive current keeps increasing, which caused a single-phase earth fault in power grid and rapid expansion of the accident. Firstly, the small current grounding system is briefly introduced in this paper. Then according to the research on the change of steady state and transient state, line selection methods are designed for different electric parameters. Active protection method for single-phase grounding fault happens in small current grounding system is put forward. This method selects the fault line according to the difference of high frequency component amplitude of zero sequence current before and after the fault and polarity of zero sequence current after the bus initiatively grounds. Finally in order to prove the validity and effectiveness of the proposed method, simulation model is built in PSCAD/EMTDC with the overhead line using the Bergeron model. The output current of different lines is then decomposed by the wavelet transform.

Introduction

Single-phase grounding fault of small current grounding system causes more and more power grid accident, expansion of the single-phase grounding accident is also commonly, bring more and more loss of economic and social benefits. Although the system can continues to run under the condition of single-phase earth fault, fault relatively higher voltage, especially intermittent arc grounding fault, which can produce arc over-voltage even damage to the insulation system and equipment safety. At the same time, the overvoltage may lead to ground fault into alternate fault or cause the power outage. Therefore, we need to determine the fault line and fault point location quickly after the single-phase earth fault, in order to take further measures to ensure the safe operation of the system, improve power supply reliability, reduce the power loss.

The active protection of the small current grounding system

The active protection of the small current grounding system can realize arc suppression.

Arc suppression coil in the small current grounding system can compensate the capacitive current of power grid, but with the development of urban and rural power grids and industry, the capacitive current is bigger and bigger, it is harder to realize completely compensated. The active grounding[1] protection can tell apart the fault phase by line voltage, zero sequence voltage and the

change of earth current. If single phase grounding fault is occurred, the rapid switch ground accurately and rapidly, making grounding network and grounding phase earth repeatedly and completely, forcing grounding phase to have the same level with the earth, in order to transfer grounding current of the grounding fault point and make it tend to be zero, finally, the arc can't maintain and go out.

The active protection of the small current grounding system can realize personal safety protection effectively.

In small current grounding system, single-phase earth fault can produce arc voltage[2] .The arc voltage has serious hazard, its temperature as high as thousands of degrees Celsius which can damage the equipment even produce explosion or cause the fire, threatening the safety of life and property. Especially in electric power industry, it is more likely to cause accidents, or even personnel casualties due to the particularity of the industry, even if the power does not produce arc for strong arcing ability, the fault phase voltage increases, the equipment's fault phase has higher work voltage, if equipment insulation break down, the short circuit may release energy, lead to more accidents in a short time[3]. In urban and rural areas with more population, if let the grounding line run and don't make it cut off immediately, it is likely to result in serious consequences and great harm to the social and economic benefits[4]. Arc suppression coil in the small current grounding system can compensate the capacitive current of power grid, but with the development of urban and rural power grids and industry, the capacitive current is bigger and bigger, it is harder to realize completely compensated. The active ground protection can tell apart the fault phase by line voltage, zero sequence voltage and the change of earth current. If single phase grounding fault is occurred, the rapid switch ground accurately and rapidly, making grounding network and grounding phase earth repeatedly and completely, forcing grounding phase to have the same level with the earth, in order to transfer grounding current of the grounding fault point and make it tend to be zero. In this way, we can realize safety protection if it happened to personal sense of power, grounding and grounding fault caused inside the equipment and safety protective short circuit and over voltage and so on.

Test results

We make research on the 10 KV small current grounding system in PSCAD/EMTDC as shown in Figure 1, using the Bergeron model. A phase ground short circuit of line 1 is set up at 0.1s in 50% of the bus, its duration is 0.06 s. We make A phase of the bus ground actively at 0.12s, its duration is 0.05s and simulation step length is 10μs.

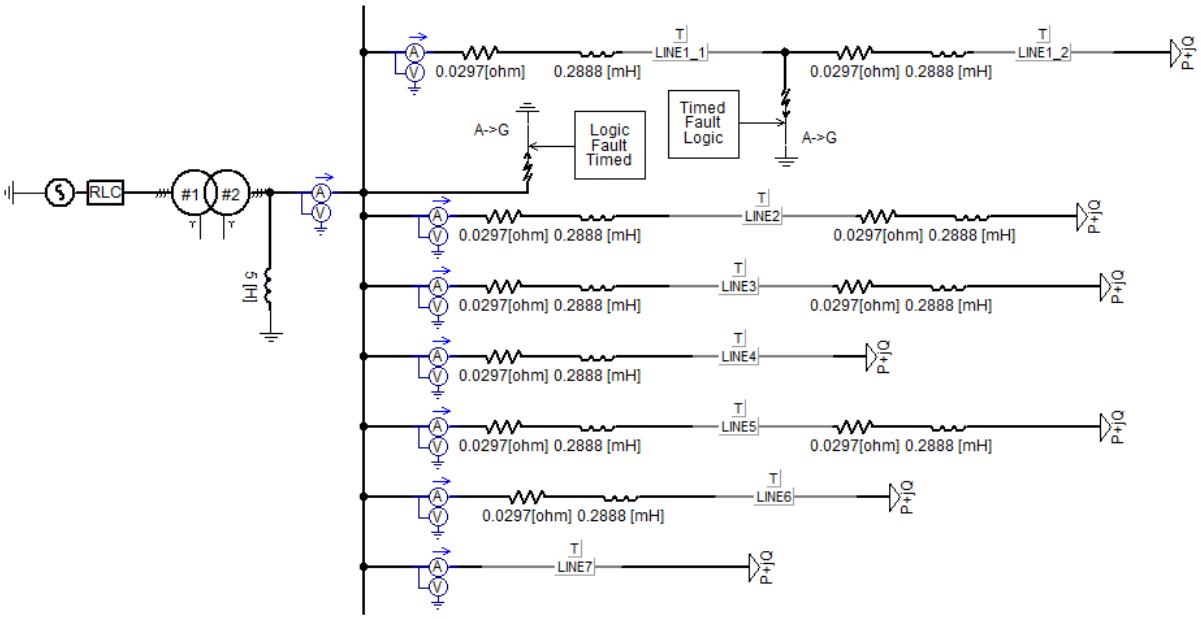


Figure 1. Single-phase grounding fault of 10KV small current grounding system

Firstly, we should judge the fault phase in line selection of the small current grounding system, when the system has a failure, phase currents of bus are shown in Figure 2.

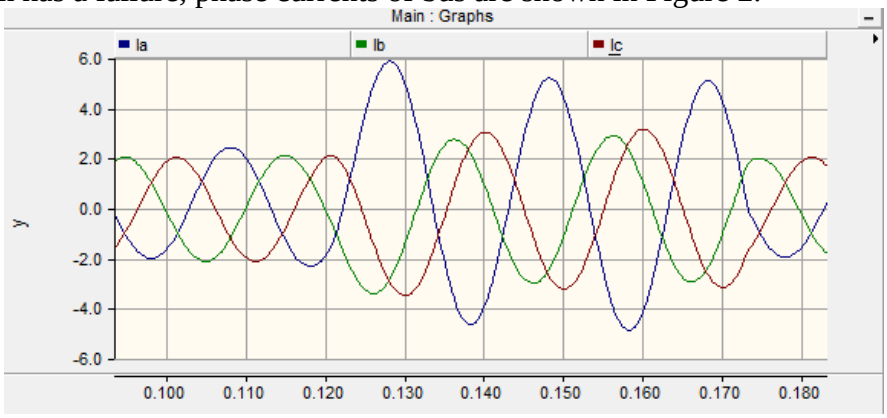
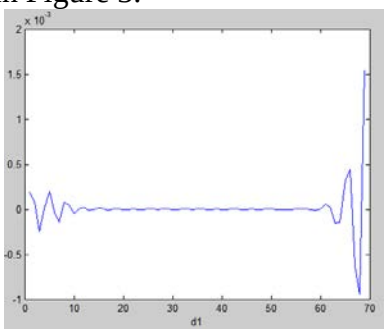


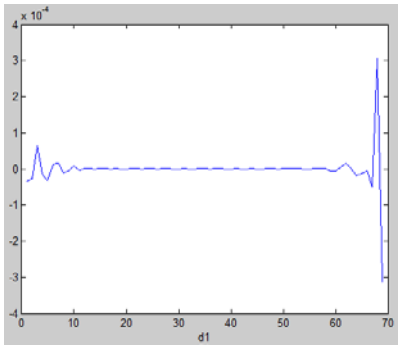
Figure 2. Phase currents of bus

As is shown in Figure 2, A phase current of the bus increases suddenly, so we judge that A phase has short circuit fault.

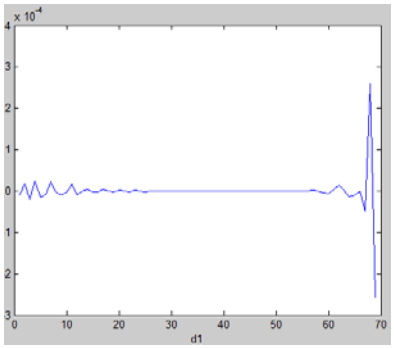
When the system has short circuit fault, we use DB10 wavelet to deal with waveform of each line from 0.1s to 0.12s. Zero sequence current amplitude[5] and polarity changes of each line on d1 scale decomposition are as shown in Figure 3.



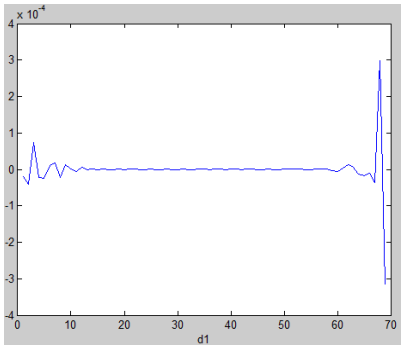
(a)Line 1



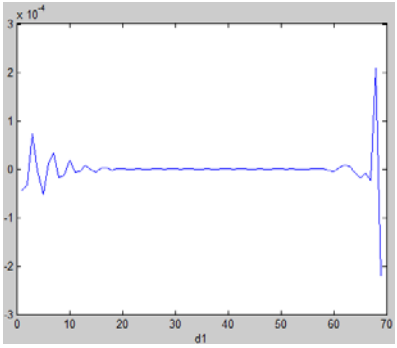
(b)Line 2



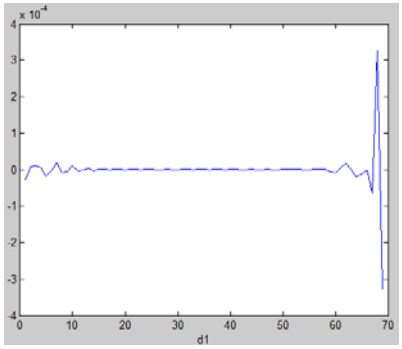
(c) Line 3



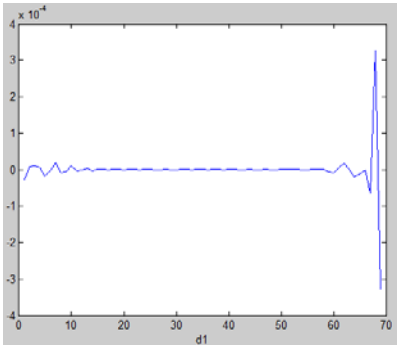
(d) Line 4



(e) Line 5



(f) Line 6



(g) Line 7

Figure 3. Zero sequence current amplitude and polarity changes of each line on d1 scale decomposition

The simulation results show that the high frequency component of modulus maxima on line 1 is the largest, and the zero sequence current of line 1 has direction contrary to other circuit polarity.

In order to improve the accuracy of line selection, we use the active ground fault protection principle to further illustrate and validate line selection results. Combined with the results of simulation in Figure1 that the system fault phase is A phase, we make A bus ground actively, zero sequence currents of each line are shown in Figure 4.

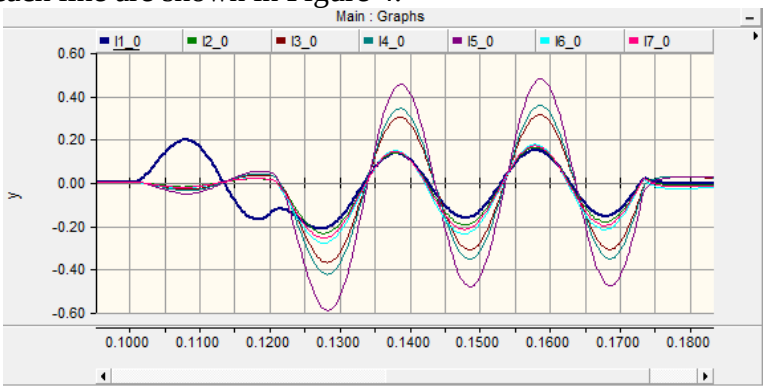


Figure 4. Zero sequence current of each line

We make A phase ground actively when A phase has a failure about 20ms.The simulation results show that the zero sequence current polarity of the fault lines changes contrary to the normal line around 1/4 of A cycle when actively ground the fault phase of the bus. Combined with the wavelet transform modulus maxima, we can determine line 1 has A phase ground fault. Line selection results agree with the simulation Settings. The results show the reliability and accuracy of line selection method in this paper.

Conclusion

This paper study active protection of the small current grounding system when single-phase has grounding fault, and put forward the protection method based on active grounding. using wavelet transform to identify the fault line according to changes of zero sequence current amplitude and polarity before or after the fault condition, then we make fault phase bus active grounding to study changes in circuit of electric parameters before or after the active grounding by PSCAD/EMTDC, in order to further improve the reliability of line selection. The line selection methods make a great significance to solve problems of arc and personal safety protection in small current grounding system, it can ensure the system has a safe and reliable operation which will bring excellent safety and economic benefits.

References

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