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Fault location algorithm for partial coupling double-circuit transmission lines

Chen Youhui

State Grid Liaoning Electric Power Co,Ltd. Power Electric Research Institute, Shenyang 110015,

Abstract: *Multi-circuit transmission lines on the same tower have become the inevitable trend of power grid construction, mostly partial coupling mode. Affected by the partial coupling characteristics, the existing fault location methods have large error. Therefore, this paper develops a study about the fault analysis and fault location method for the partial decoupling double-circuit transmission lines. Based on its structure and characteristics, as well as the lines decoupling theory, the interface equations of demarcation point are built. On the basis of the above study, the new fault location algorithm based on time-domain for partial coupling double-circuit transmission lines are presented. Finally, ATP/EMTP is used to construct the model of partial coupling of double-circuit transmission lines. After the overall simulation and verification, it shows that the presented algorithm is accurate.*

Keywords: *partial coupling; double-circuit transmission lines on the same tower; fault location; interface equation*

1. Preface

Once the transmission line fails, it will destroy the stable operation of the power system. Accurate fault location is conducive to timely repair of lines and rapid restoration of power supply. However, the same-tower multi-circuit power transmission method shares the tower, which requires a narrow transmission corridor[1-4],which can make full and effective use of the limited transmission corridor resources and increase the unit transmission capacity. Therefore, the same-tower multi-circuit power transmission method is bound to become the focus of power grid planning and construction. However, in actual projects, it is not common to use multi-circuit lines for power transmission on the whole line, and most of them are local coupling modes of multi-circuit lines[5].At present, most of the coupled line fault analysis methods are aimed at complete multi-circuit lines on the same tower, and are based on the decoupling method of complete lines on the same tower. Compared with the multi-circuit transmission mode on the same tower, in the multi-circuit transmission mode with partial coupling, there is at least one coupling demarcation point. Each side of the coupling demarcation point has different characteristics, and the line parameters and modulus characteristics are also different. Existing fault analysis methods do not consider the influence of local coupling between lines, so the distribution characteristics of zero sequence current cannot be accurately expressed. The existing fault location methods are mainly divided into traveling wave method and fault analysis method, and the fault analysis method is divided into frequency domain method and time domain method.

The frequency domain method is based on the faulty power frequency electrical quantity and the long-term equation model. The required data time window is longer, but the accuracy and stability are high; limited by the data time window, the frequency domain method often leads to measurement due to insufficient data time window. Distance failed. The time domain law is based on the Bergeron model and electrical instantaneous quantities, and the required data time window is relatively short, which can be used as an effective supplement to the frequency domain method. At present, the research on fault location of multi-circuit coupled lines is mostly carried out around multiple circuits on the same tower[6-7].For example, literature[8]considers zero-sequence mutual inductance. According to the sequence network and fault boundary conditions of different types of faults, Aiming at the single-circuit fault of the double-circuit line on the same tower, a fault location algorithm based on the two-terminal electrical quantities of the faulted line is proposed, and it is not affected by the transition resistance, system impedance and load current. Literature [9] uses the J.Marti model to propose a mode conversion analysis method suitable for fault location of the four-circuit line on the same tower. On this basis, a dual-terminal fault location for the four-circuit line on the same tower based on the circulation mode component is proposed. Frequency domain algorithm. In addition, for special types of lines such as

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T-type lines, literature[10]uses the pure resistance properties of transition resistances to propose a new three-terminal fault location method for T-type lines. This method does not need to judge the faulty branch first to measure the distance.

2. Interface equation at the local coupling boundary

At present, there is no report on the fault location method of locally coupled multi-circuit line. Misoperation of zero-sequence protection or grounding distance protection due to coupling line faults often occurs, and zero-sequence coupling between lines will inevitably affect the accuracy of fault location. Therefore, it is necessary to study the time-domain fault location method for locally coupled multi-circuit lines. To this end, this paper conducts fault analysis and fault location research on time domain methods for partially coupled double-circuit transmission lines.

3. Time-domain distribution equation of voltage and current along the line

According to the structure and characteristics of the partially coupled double-circuit transmission line on the same tower, the multi-circuit decoupling theory is used to establish the voltage and current interface equations at the coupling demarcation point of the partially coupled double-circuit transmission line. On this basis, a time-domain equation of fault location for each coupling section is constructed, and a time-domain method of fault location for locally coupled double-circuit transmission lines is proposed. Finally, use ATP/EMTP electromagnetic transient simulation software to build a partially coupled double-circuit transmission line model on the same tower for comprehensive simulation verification. As shown in Figure 1.

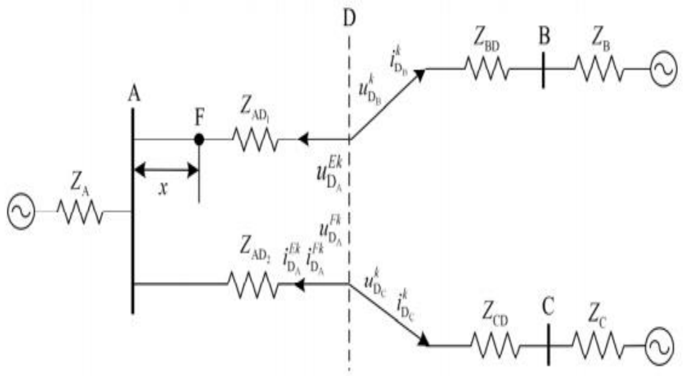

Figure 1 Coupling double-circuit transmission lines on the same tower

4. Time domain algorithm for fault location

In this paper, the fault line is divided into multiple calculation observation points at equal intervals (the calculation distance is dx). According to the foregoing calculation method, combined with the electrical quantities at each end of the coupled line, the models are respectively calculated from the two ends of the fault line to each calculation observation point. Measure the instantaneous voltage, and calculate the instantaneous voltage difference between the two ends of each observation point. If the observation point is closer to the fault point, the estimated instantaneous voltage difference will be smaller; otherwise, the difference will be larger. The above-mentioned law is established at any time after the failure. Therefore, a fault location observation model can be constructed by selecting multiple sets of sampled data at different times, and finding the lowest point of the voltage difference to determine the fault point. According to different fault segments, there are different fault location observation models. As shown in Figure 2.

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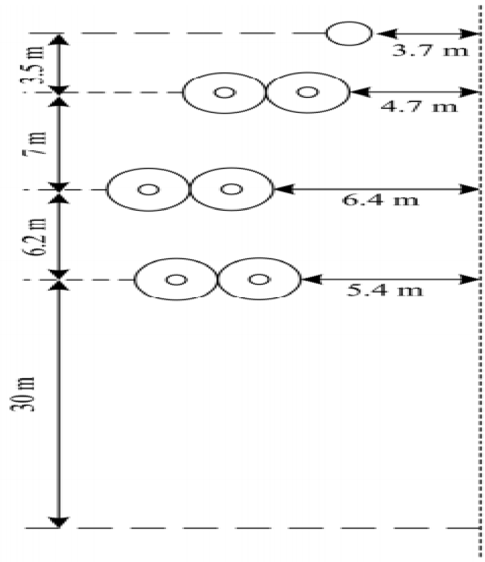

Figure 2 Coupling double-circuit line tower layout

5. Simulation, analysis and verification

In order to verify the difference between the proposed algorithm and the traditional algorithm, a single-phase metallic ground fault was set at a distance of 10km (coupled double-circuit section) and 30 km (single-circuit section) from end A, and then unconsidered lines were used. The traditional ranging algorithm and the method proposed in this paper are used to calculate the fault location. In order to verify the ability of the proposed method to withstand the transition resistance, a comprehensive simulation analysis and verification was carried out. In order to conduct a comprehensive analysis and verification, different fault types, fault distances and transition resistances are set respectively. Through a large number of simulation analysis, the method proposed in this paper is used to calculate the fault location.Through the above-mentioned fault simulation analysis, it is proved that the method proposed in this paper has high ranging accuracy, is not affected by the transition resistance, and solves the influence of local coupling between lines.

References

[1] SHANG Liqun, LIANG Wenli. Review of high voltage DC transmission lines fault location [J]. High Voltage Apparatus, 2016, 52(8): 1-6.

[2] KANG Zhongjian, TIAN Aina, FENG Yanyan, et al.Fault section locating method based on zero sequence impedance model fault feature in distribution network with distributed generators [J]. Transactions of China Electrotechnical Society, 2016, 31(10): 214-221.

[3] XIA Yi, TAI Nengling, FAN Chunju, et al. Four zero-sequence component method of asymmetry parameter four-parallel lines on the same tower and its ault analysis [J]. Power System Protection and Control, 2013, 41(18): 9-16.

[4] JIANG W Q, LIU Q J, LI C J. Review of fault location for double-circuit parallel transmission lines on the same pole[C] // APAP, 2011, 2: 1125-1129.

[5] GAO Yanfeng, ZHU Yongli, YAN Hongyan, et al. A new fault location method of transmission lines based on double-terminal traveling wave [J]. Power System Protection and Control, 2016, 44(8): 8-13.

[6] LIU Zhenzhi, SHU Qin, HAN Xiaoyan, et al. An iterative fault location algorithm using the difference of wave velocity between zero mode component and aerial mode component of traveling wave [J]. Power System Protection and Control, 2015, 43(8): 88-93.

[7] XU Jie, ZHANG Yongjian, SUN Jia, et al. Single terminal travelling waves location based on pattern recognition [J]. High Voltage Apparatus, 2012, 48(6): 28-33.

[8] YU Zhongan, CHENG Mingzhao, GUO Peiyu, et al. A new fault locating of T-type transmission line consisting of four parallel-line and double circuit [J]. Power System Protection and Control, 2014, 42(15): 8-14.

[9] FAN Guochen, ZHU Yongli, SHI Jinmao, et al. Fault location scheme for transmission lines using Kaiser self convolution windowed FFT phase comparison[J]. Power System Protection and Control,

ISSN 2616-5767 Vol.4, Issue 9: 32-35, DOI: 10.25236/AJETS.2021.040906

2015, 43(7): 143-148.
[10] WU Biao, YU Zhongan, ZOU Hao, et al. Fault location for four-parallel transmission lines on same tower based on ant colony algorithm [J]. Power System Protection and Control, 2015, 43(20): 45-50.