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Locus of apparent impedance of distance protection in the presence of SSSC

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SUMMARY

This paper presents the measured impedance at the relaying point of compensated transmission lines with SSSC under different fault conditions. The locus of the apparent impedance under different system operation and fault condition is obtained whilst fault location and resistance are changed. It is shown that the presence of SSSC on a transmission line has a great influence on the apparent impedance, which itself is influenced by the line short circuit level, pre-fault loading, and especially the fault resistance. The structural and controlling parameters of SSSC, as well as its installation location, can affect the measured impedance and consequently the locus of apparent impedance. The paper derives a mathematical expression of the apparent impedance, which includes all the affecting parameters. Copyright © 2010 John Wiley & Sons, Ltd.

KEY WORDS: distance protection; FACTS devices; locus of apparent impedance; transmission lines; SSSC

1. INTRODUCTION

The measured impedance at the relaying point is the basis of distance protection operation. There are several factors affecting the measured impedance at the relaying point. Some of these factors are related to the power system parameters prior to the fault instant, which can be categorized into two groups: structural and operational conditions [1–3]. In addition to the power system parameters, the fault resistance could greatly influence the measured impedance, in such a way that for zero fault resistance, the power system parameters do not affect the measured impedance. In other words, power system parameters affect the measured impedance only in the presence of the fault resistance, and as the fault resistance increases, the impact of the power system parameters becomes more severe.

More than 70% of transmission line faults are single phase to earth faults, and phase to phase faults are the next common fault type. Double phase to earth and three phase faults are less common in power transmission systems.

In the recent years, Flexible Alternating Current Transmission System (FACTS) devices have been introduced into power systems to increase transmission line capacity. This is done by pushing the operation point of power systems to their thermal limits. It is well documented in the literature that FACTS devices have great influences on the system dynamics and hence its protective devices. Therefore, it is essential to study effects of FACTS devices on distance relays as the main protection system of transmission lines.

Unlike the power system parameters, the structural and controlling parameters of FACTS devices, as well as their installation position could affect the measured impedance in the case of zero fault resistance. In the presence of FACTS devices, the conventional distance characteristic are greatly

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