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Location of faults in power distribution laterals using superimposed components and programmable logic controllers

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ABSTRACT

In this study, a digital fault location and monitoring technique using programmable logic controller (PLC) for primary overhead power distribution networks is presented. This technique employs pre- and post-fault current and voltage information along with data from the laterals. By using lateral current data transferred through shielded coaxial cables to the substation, the possibility of multiple fault point locations are eliminated. The effectiveness of this method is verified through Electromagnetic Transients Program (EMTP) simulations.

1. Introduction

Overhead radial distribution lines are simple, very low cost and therefore the most common form of lines that are used in distribution systems. Radial distribution systems branch into various primary laterals. A fault occurrence at any location on a radial distribution system causes a power outage for every consumer on the system unless the fault can be isolated from the source by a disconnecting device such as a fuse, sectionaliser, recloser or circuit breaker [1,2]. The present practice to locate a fault is such that on the occurrence of a fault, each feeder is opened and closed in turn until the faulty circuit is identified. Sectionalising then takes place on the feeder until the fault is located. During this process, the supply to the consumers may be interrupted. Hence there is a requisite for power companies to employ accurate fault locators at substations; this would cut down inspection and service restoration times, minimise outage times and provide a high quality of supply to customers.

Many researchers have developed digital fault location techniques with a major emphasis on transmission lines and relatively less work has been done in distribution lines [3–10]. The fault location algorithms developed for transmission lines are not suitable for distribution networks due to significant differences in physical structures and dimensions between the two systems [11]. The technique developed in [12] requires a communication medium and fault recorded data from all ends of the transmission system need to be synchronised. In this technique by matching the voltage or current phasors obtained by recording devices with those generated in the corresponding simulation studies, the fault is located in an iterative way. Although the approach offers very accurate results, it is not tested for an overhead distribution system. More recently global positioning system (GPS) of satellites for performing data sampling to locate the shunt faults in transmission networks was presented in [13]. Although very accurate results are obtained by this technique, the initial and operational costs are very high.

In the technique reported in references [14,15] to locate shunt faults in power distribution systems, the high frequency (HF) signals which generated under arcing faults are utilised. In this approach, by using line traps and stack tuners any high frequency components over a specific band of frequencies are confined to the protected line and the direction of the fault is found. However, directional fault locators can be useful in inter-meshed distribution networks, but in longer radial distribution lines, the initial costs would be prohibitively high. In [16] a review of impedance-based fault location methods using single point measures available in the literature for radial distribution systems is presented. More recently, some other impedance-based approaches have been proposed for overhead three-phase radial distribution lines with single-ended measurements [17–19]. However, all these have either limited application or they suffer from an increase in inaccuracy due to the combined effect of the load current and fault resistance, inaccurate fault type, load flow unbalance, line loading and the presence of distributed generation (DG) units. Moreover, fault location algorithms based on apparent impedance, may experience difficulty in distinguishing a fault location between a fault on a lateral or the main line [11,16]. The application of artificial intelligence approach on fault location schemes, as Wavelets and

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