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Analytical synchronization of two-end voltage and current measurements under transmission line load conditions

Abstract.

Keywords: power transmission line, transposed line, load conditions, unsynchronised digital measurements, analytical synchronisation.

Measurement of current and voltage signals from two ends of a transmission line can be performed synchronously, if the GPS (Global Positioning System) is available. Use of such synchronized two-end measurements allows simple and accurate fault location for the inspection-repair purpose or estimation of line parameters. Otherwise, including also the case of loss of the signal from the GPS, the digital measurements from the line terminals are acquired asynchronously and do not have a common reference. In order to make the unsynchronised measurements useful for fault location, an analytical synchronization can be performed.

With use of analytical synchronisation, potential synchronization errors due to synchronizing device failures could be easily detected as well. Such synchronization errors may be caused by various reasons, as for example by improper hardware wiring, communication problems or loss of the signal from the GPS. Such defects can be detected with use of the easily and accurately determined synchronization angle.

In this paper analytical synchronisation of digital measurements of three-phase current and voltage signals from two ends of a transposed transmission line is considered. Use of pre-fault positive-sequence currents and voltages (Fig. 1 – superscript "pre") is considered for making the synchronisation. For this purpose the measurements from the bus B are assumed as the basis, while all phasors of the current and voltage signals from the end A are multiplied by the synchronisation operator: exp(j), where is the synchronisation angle to be determined.

First, the unknown synchronisation angle is strictly determined by considering the equivalent circuit diagram of Fig. 1 and assuming that the line parameters for the positive-sequence: $\underline{\gamma}_1$ – propagation constant, $\underline{Z}_{c1}$ – surge impedance are known. Then, taking into account that the line parameters are dependent on atmospheric conditions and thus have to be considered to some extent as unreliable parameters, the analytical synchronization of measurements is performed without utilizing line parameters. It is shown that even some simplification assumption is taken into account the synchronization angle can be determined enough precisely for practical applications.

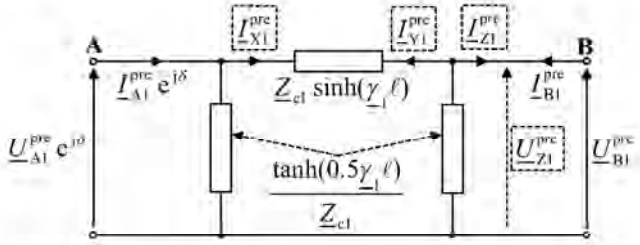

Fig.1. Distributed-parameter model of transmission line for pre-fault positive-sequence with specifying the measured signals (the signals used in calculations are marked with dashed boxes)

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