

## Distance Elements: Linking Theory With Testing

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### Abstract

Most of the time, distance element testing does not link the theory related to distance element design to the fault voltages and currents. This paper is a discussion of the theory and testing of particular ground and phase elements. Concepts include the impedance characteristics, the SIR (source impedance ratio), fault resistance, and load flow behavior. The discussion will touch on procedural errors when testing and the influence of fault supervising elements, like overcurrent fault detectors and directional elements. The characteristics of distance elements can be exposed by calculating the symmetrical component fault quantities. The paper aims to clarify the theory required to test distance elements by deriving their characteristics and linking the discussion to the testing of distance protection relays when a new relay model is incorporated into a power system.

### Discussion Points

6. The characteristics of distance elements are analyzed, which is a not widely available in other literature. The phase comparator concept and the derivation of impedance characteristics are discussed.
7. The paper promotes testing distance elements with symmetrical components, which clearly exposes the characteristics of the distance elements.
8. Associated topics, like overcurrent fault detectors and directional units, are considered when testing distance elements.
9. The discussion clarifies concepts including apparent impedance, positive-sequence impedance plane and source impedance ratio, and load flow and fault resistance influence on element characteristics.