

# J6

## Impact of Frequency Deviations on Protection Functions

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The subject of response of protection function to frequency deviations gained interest among relay users and regulatory bodies in the light of the 2003 Blackout investigation and subsequent NERC activities.

This paper looks at performance of a wide variety of protection functions under abnormal system frequencies. Functions we will review include:

- Instantaneous, directional or non-directional phase over-current functions;
- Instantaneous, directional or non-directional neutral and negative-sequence over-current functions;
- Time-coordinated over-current and voltage functions;
- Line and bus differential functions;
- Transformer differential functions with harmonic inhibits;
- Impedance and distance functions, including memory polarization;
- Sensitive capacitive protection functions.

The paper focuses on both security and dependability under a number of events of interest combined with off-nominal frequency. The events of interest include internal and external faults, transformer inrush, line pickup and other traditionally considered protection events. The off-nominal frequency events focus on real-world scenarios that produce frequency deviations as well as stable and unstable power swings.

With reference to microprocessor-based relays, the paper explains digital measurements under varying fundamental frequency, and reviews concepts of frequency compensation and frequency tracking. The paper also reviews practical methods used to measure frequency in microprocessor-based relays.

This tutorial paper will provide insights into internal workings of typical microprocessor-based relays and educate protection engineers regarding possible responses of protection functions under dramatic frequency events in the power system.

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