Partial Differential Relaying

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"Partial differential" relaying is a form of overcurrent relaying frequently used to detect main bus overcurrent faults and to back up feeder overcurrent relaying. The basic circuit is shown in the one-line diagram. Note that this is a double-ended substation, with two main breakers and a tie breaker. The partial differential relaying concept cannot be used on a straight radial distribution system.

![Diagram of partial differential relaying](image)

True bus differential relaying compares all currents entering and leaving a switchgear bus. Within the limits of the accuracy of the CT's and the relays, true bus differential relaying will detect all faults on the protected bus. Since all currents are taken into account, the relays can be very fast. However, bus differential relaying provides no backup to the feeder overcurrent relaying, so additional overcurrent relays are required on main and tie breakers to provide this backup function. Also, high speed bus differential relaying can be quite expensive, and many switchgear users do not feel that it is economically justified.

Partial differential relaying sums the currents entering or leaving a switchgear bus through main and tie breakers. If a fault exists on the protected bus, the currents will add in the relays, but if fault current is flowing through the bus to a fault on another bus, the currents will subtract and the relays will not respond. If the fault is on a feeder, the partial differential relays will act as backup to the feeder overcurrent relays.
Similar protection can be obtained by using separate overcurrent relays on each main and tie circuit breaker. However, proper coordination of the overcurrent protection requires that the tie breaker relays coordinate with the feeder relays and that the main breaker relays coordinate with the tie breaker relays, for a total of three steps of relaying at this bus. Using the partial differential circuit, however, eliminates one step of coordination, since the same relays serve both the main and the tie breakers without compromising coordination. This reduces the time delay required for the main breaker relays and improves the chances of getting good coordination with upstream relays, which are often on the utility system serving the substation. This improved coordination is the principal benefit of partial differential relaying.