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Synchronization or Paralleling of Generators

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Abstract

Synchronization or paralleling of generators is an essential technique in modern electrical power systems that enables two or more generators to operate simultaneously and supply power to a common electrical load. The process involves connecting an incoming generator to an energized bus only when its voltage, frequency, phase sequence, and phase angle are properly matched with those of the existing power system. Accurate synchronization is necessary to prevent excessive circulating currents, mechanical shocks, voltage disturbances, and possible damage to the generators and associated equipment. In practical applications, synchronization can be performed manually or automatically using synchronizing lamps, synchroscopes, or modern automatic synchronizing relays and control systems. Once generators are successfully connected in parallel, their real and reactive power outputs can be controlled through the prime-mover governor and excitation system, respectively. Paralleling provides several advantages, including improved system reliability, greater operational flexibility, better load sharing, increased efficiency, and continuity of power supply during maintenance or generator failure. It is widely used in power stations, industrial plants, commercial facilities, and standby power systems. This study focuses on the fundamental principles, synchronization conditions, methods, protection requirements, and load-sharing techniques associated with generator paralleling. Proper synchronization and control ensure stable, safe, and efficient operation of multiple generators while maintaining acceptable system voltage and frequency.

Keywords: Generator synchronization, generator paralleling, phase sequence, voltage matching, frequency matching, phase angle, load sharing, synchronizing relay, excitation control, power system stability.