



Title: Measurement-Based Analysis of Motion Control of a 110,000 rpm Single-Phase BLDC Motor for Fuel Cell Air Compressors

Abstract: Hydrogen-based energy systems are attractive because hydrogen has a theoretical specific energy of up to 33,000 Wh/kg, which is significantly higher than that of conventional lithium-ion batteries (typically 100–260 Wh/kg). In hydrogen fuel cell systems, centrifugal air compressors driven by high speed motors are commonly used to supply oxygen because of their compactness, simplicity, and high reliability. Therefore, high-speed motors are critical components in such hydrogen fuel cell applications. However, in the research and development (R&D) of high-speed motor systems, it is difficult to simultaneously measure all gate signals with a standard oscilloscope because of the limited number of oscilloscope channels and the presence of floating potentials. Moreover, accurately capturing the transient electrical behavior of high-speed motors under high-current conditions is another challenge because current probes can saturate at high currents. To address these issues, this study presents measurement-Based analysis of the motion control strategies of a single-phase permanent magnet brushless DC motor (SPPMBLDC) that can reach a maximum speed of 110,000 rpm. By analyzing MOSFET gate-drive control signals and Hall sensor signals, the control strategies were characterized in different operating phases: spin-up, acceleration, and high speed steady-running phases. Additionally, experimental results, including the measured winding current and DC-link voltage, are provided.