

Influence of high switching frequencies employing wide band gap semiconductors on encoderless control schemes

Research Focus

The impact of high switching frequencies on the control of electrical machines, with a particular focus on encoderless control schemes, is to be analyzed. Problems arising from the use of wide band gap semiconductors in motor control will be identified and countermeasures will be developed to ensure stable and dynamic encoderless control of the drive system.

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Links

- <https://ultrazohm.com/>
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Short Description

Wide band gap semiconductor, e.g. silicon carbide (SiC), allow for fast switching transients, leading to reduced switching losses and enabling higher switching frequencies with the additional benefit of reduced conduction losses compared to silicon (Si) insulated-gate bipolar transistors (IGBTs).

However, employing SiC inverters in motor control introduces additional challenges, such as increased stress on the winding insulation. Furthermore, the high dv/dt rate, in combination with an increased switching frequency, can negatively affect the current measurement, as the available measurement window is reduced while the excitation of parasitic capacitances leads to current oscillations.

Encoderless control schemes are typically divided into two groups: fundamental methods, which fail at standstill, and anisotropy-based methods, which rely high-frequency signal injection.

For anisotropy-based encoderless control methods, a high-quality current measurement is essential, as the rotor position signal is derived from the measured phase currents. In addition to the challenges already mentioned, eddy currents at higher frequencies can further reduce the signal-to-noise ratio.

To reduce the high-frequency effects, a power output filter can be designed. This filter is likely to influence the encoderless control, requiring either an adaption of the existing control algorithm or the development of a new encoderless control method.

Publications

S. Klass, H. Börngen, D. Manoharan, R. Kennel and M. L. Heldwein, "High-Frequency Switching of State-of-the-Art Wide Band Gap Inverters and its Impact on Encoderless Control Schemes," *2023 IEEE 8th Southern Power Electronics Conference and 17th Brazilian Power Electronics Conference (SPEC/COBEP)*, Florianopolis, Brazil, 2023, pp. 1-7, doi: 10.1109/SPEC56436.2023.10407581.