



Inverter for Common Mode Voltage Cancellation

[View U.S. Patent No. 9,917,543 in PDF format.](#)

WARF: P160142US01

Inventors: Bulent Sarlioglu, Di Han

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in a novel inverter topology for motor drives that eliminates problems with common mode voltage (the voltage difference between the power source ground and the neutral point of a three-phase load).

Advantages of this technology include reduced electromagnetic interference emissions, elimination of CM filters, increased machine reliability and extended bearing life.

Overview

In a drive system, a voltage source inverter (VSI) may be used to transfer real power from a DC power source to an AC load. Conventional VSIs consist of two or three phase-legs, each of which is a series connection of two semiconductor switches.

During normal operation, the output potential of each phase-leg with respect to ground is continuously switched between a positive and a negative DC bus potential based on a pulse width modulation of the switches. As a result, undesired common mode (CM) voltage imposed on the load also exhibits six step-changes during each switching cycle. Each step-change induces a charging or discharging current into the parasitic capacitances between load and ground that leads to issues such as electromagnetic interference emissions, inverter losses and motor damage. The bearing damage in inverter-driven motors is mainly caused by the shaft voltage and the bearing currents created by CM voltage.

CM chokes and filters may be used to mitigate the CM voltage-induced issues. However, since CM chokes have to block a significant amount of CM voltage, they are bulky and constitute a large portion of the product cost.

The Invention

UW-Madison researchers have developed inverter topology in which the CM voltage is 100 percent cancelled. Instead of the two switches in series (as found in conventional designs) the new 'balanced inverter' features three switches in series wherein the upper and lower switches of each phase-leg are rated at half the DC bus voltage.

The half-rated switches turn on and off simultaneously. The middle switch of each phase-leg operates complementarily with the other two, and is rated at the full DC bus voltage. This essentially replaces one full voltage-rated switch with two half-rated switches on the top and bottom of each phase.

The new topology cancels the total CM voltage by generating two equal-amplitude, opposite-signed CM voltages on the two sets of three windings. Hence, the whole machine remains at ground potential, and no current will flow to the ground. In addition, to take advantage of the six AC terminals of the machine, the new topology is used to create separate two sets of windings. This can be done by reconfiguring the series connected machine windings, which is particularly convenient for dual-voltage 9-lead machines.

OK



Applications

- For use in electric motor drives including industrial and commercial drives, traction drives for hybrid/electric vehicles, generator and motor drives for aircraft and vessels

Key Benefits

- Cancels CM voltage generation
- Reduces electromagnetic interference (EMI) emissions
- Eliminates CM filters
- Eliminates ground leakage current and corresponding losses
- Prevents false triggering of ground fault protection
- The shaft voltage and bearing current on the electric machine can be eliminated for increased reliability and extended bearing life.

Stage of Development

The researchers have simulations and calculations indicating 100 percent reduction of CM voltage peak amplitude and number of step changes, compared to a conventional inverter. The researchers have engineering prototype and experimental data showing up to 40 dB reduction in CM EMI emission.

The development of this technology was supported by WARF Accelerator. WARF Accelerator selects WARF's most commercially promising technologies and provides expert assistance and funding to enable achievement of commercially significant milestones. WARF believes that these technologies are especially attractive opportunities for licensing.

Additional Information

For More Information About the Inventors

- [Bulent Sarlioglu](#)

Related Technologies

- [To learn about innovative flux-switching permanent magnet \(FSPM\) machines developed by Prof. Sarlioglu, see WARF reference numbers:](#)
- [P150249US01](#)
- [P140405US01](#)

Tech Fields

- [Engineering : Power electronics & control systems](#)

For current licensing status, please contact Michael Carey at mcarey@warf.org or 608-960-9867

We use cookies on this site to enhance your experience and improve our marketing efforts. By continuing to browse without changing your browser settings to block or delete cookies, you agree to the storing of cookies and related technologies on your device. [See our privacy policy.](#)

OK



WARF
Wisconsin Alumni Research Foundation

| info@warf.org | 608.960.9850