Commutation Torque Ripple Suppression Strategy for Brushless DC Motors With a Novel Non-inductive Boost Front End

Introduction:

Brushless dc motors (BLDCMs) have been widely used in many applications owing to their simple structure and high torque density. However, the commutation torque ripple (its maximum may reach 50% of the average torque) is produced in the commutation process as the stator inductance and the finite DC-link voltage restrict the rapid change of the phase currents.

This commutation torque ripple can cause noise and vibration, which is one of the main problems to limit the high performance operation of BLDCM.

Existing system:

The pulse width modulation (PWM) on the non-commutation phase is employed to keep the average terminal voltage constant during the commutation process via voltage disturbance compensation. As this method is not suitable for the motor operation in the high-speed region below the rated speed, many scholars pay their attention to the commutation torque ripple suppression over the full speed range.

A method with a single DC current sensor is proposed, in which the full speed range below the rated speed is divided into the high-speed region and the low-speed region, and different modulation strategies are used accordingly during the commutation process to...
Keep the current slope of the in-coming phase equal to that of the out-going phase with the voltage compensation method.

**Dis-advantages:**
- Not suitable for the motor operation.
- Reduce the stability of the system.

**Proposed system:**
Unified commutation torque ripple suppression is proposed with a designed non-inductive boost front end. BLDCM normally operates in two-phase conduction mode. However, the commutated currents cannot be changed rapidly due to the existence of the stator inductance and the finite DC voltage, which results in simultaneous existence of currents in all three phases during the commutation process.

Therefore, the two-phase conduction region is regarded as the non-commutation period and the three-phase conduction region as commutation period. Based on the combination of the main vector and the auxiliary vector, the proposed strategy can boost the capacitor voltage under the premise of guaranteeing the input line voltage required for the normal speed regulation in the non-commutation period. As to the commutation period, only $V_m1$ and $V_a0$ are selected below the rated speed to suppress the commutation torque ripple and shorten the commutation time with the boosted capacitor voltage.

**Advantages:**
- The structure of the proposed NIBFE is simple, saving the drive system size and cost.
It is possible to suppress the commutation torque ripple and shorten the commutation process at the same time, thus improves the system stability.

**Applications:**
- Motor Drive applications.
- Power conversion applications.

**Block Diagram:**

- Dc input
- Non-inductive boost front end converter.
- BLDCM drive system.
- 12VDC
- Gate driver circuit
- Buffer circuit
- 5VDC
- Microcontroller circuit