Power Cycling of Three-Level Inverters for Low Speed Operation

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Background - Low Speed Operation

- Voltage-source inverters for AC motor drives have an inherent short-cycling for generating full torque at low output frequency (low modulation index, low motor speed).
- If the output fundamental time period is comparable to the time constants of power modules, there will be a considerable swing in junction temperature and the peak temperature will correspond to the peak power dissipation rather than the average.
- Peak junction temperature will limit the maximum output current.
- The swing in junction temperature (power cycling) will reduce the life of the power module.

Low output frequency effect on junction temperature

Prior art solutions - DPWM

- DPWM: Less switching losses
- SVM: More switching losses
- Less Conduction losses

Prior art solutions - ZVM

Maximum junction temperature variance for different power factor values in a two-level Si converter with 2 Hz fundamental frequency

Three-level converter space vector

Optimal loss distribution

Comparison of ZVM, DPWM and SVM

Maximum junction temperature variance for different power factor values in a two-level Si converter with 2 Hz fundamental frequency

Algorithm for finding the optimal switching sequence

Comparison of different modulation methods

Junction temperature variation with modified methods

Implementation Issues

Conclusions

- An algorithm for finding the optimal modulation scheme for operation in low output frequency and high output power is proposed.
- The neutral point voltage imbalance is analyzed.
- It is shown that the modified method can balance the neutral point balance with minimal negative effect on peak junction temperature.