[1] : 5kVA output power single phase inverter by using enhancement mode GaN transistor at 50kHz switching frequency with the design of the output filter inductor based on a multilayer, high current PCB magnetics.

in this thesis three items are highlighted. First one is systematic approach is used to design the inverter. The losses of transistors are calculated by analytically with regarding modulation index. Second one pcb inductor design and last one is 5kVA single phase inverter which has not made up to now with GaN

[2] : This thesis develops a simplified finite-state predictive torque control (FS-PTC) algorithm based on selected prediction vectors (SPVs). The finite-state predictive torque control (FS-PTC) of motor drives is an MPC strategy. In FS-PTC, a finite number of possible control actions—voltage vectors in this study—are evaluated against control objectives (torque, flux and other system constraints) in an iterative prediction loop. After this, an optimum voltage vector is selected by minimising a predefined cost function and applied to the motor terminals via an inverter. The proposed SPVs strategy also assists reducing the average switching frequency for a two-level voltage source inverter fed induction motor (IM) drive. this thesis proposes to integrate the FS-PTC with a three-level neutral-point clamped (3L-NPC) inverter driven IM drive.

[3] : wide bandgap semiconductors (SiC, GaN), These components can switch much faster than their silicon counterpart, which can reduce converter losses and also decrease differential mode filter given the increase of switching frequency. However, such a fast commutation increases Electromagnetic

Interference (EMI) issues in the converter and loads connected to it. This paper investigate the trade-offs between losses and EMI issues of three-phase inverters used in future aircraft applications. Given the voltage DC bus of 540V, SiC MOSFETs are investigated and experimental results show the impact of these components on losses and EMI for different parameters.

[4] : Silicon carbide (SiC) MOSFETs and gallium nitride (GaN) high-electron mobility transistors are perceived as future replacements for Si IGBTs and MOSFETs in medium- and low-voltage drives due to their low conduction and switching losses. However, it is widely believed that the already significant conducted common-mode (CM) electromagnetic interference (EMI) emission of motor drives will

be further exacerbated by the high-speed switching operation of these new devices. Hence, this paper investigates and quantifies the increase in the conducted CM EMI emission of a pulse width modulation inverter-based motor drive when SiC and GaN devices are adopted. Through an analytical approach, the results reveal that the influence of dv/dt on the conducted CM emission is generally limited. On the other hand, the influence of switching frequency is more significant.

[5] : This paper is an effort to put together all the potential applications of Wide Bandgap (WBG) devices in AC electric drives. Low inductance motors, high speed motors, and electric drives operating in a high temperature environment are the main application areas of WBG devices. Low voltage permanent magnet motors and slotless motors have a low inductance and require a stringent high-bandwidth current regulation strategy to obtain an acceptable current ripple. Silicon (Si) devices cannot be used in this case due to their limited switching frequency. MW-level high speed motors have devices operating at high voltage and current levels and a high fundamental frequency (600-1200 Hz) that cause very high switching losses in Si IGBT devices. SiC devices have enabled the use of power electronic converters for MW-level high speed motors. Integrated motor drives (IMDs) are also benefitted by WBG devices as they reduce the size of the power converter and allow operation at a high junction temperature. Therefore, the inverter can be mounted on the motor itself which can be a significant heat source due to motor losses. Cooling requirements in high temperature environment applications such as hybrid Electric Vehicle (EV), ground vehicles in combat zones, and power converters used in space technology like land rovers etc., are greatly reduced due to low losses and high junction temperatures. Operation at high frequencies and high temperatures reduces the size of electric drive significantly.

[6]: Additional loss is produced when the speed of the PMSM drive system is changed with the common id=0 control strategy. Hence, in this paper, a method based on the decoupling control strategy is proposed to reduce loss of permanent magnet synchronous machines (PMSMs) in dynamic state. The new decoupling control strategy could reduce the additional loss compared with the traditional method by holding the value of id near zero. The simulation results validate the effectiveness of the proposed decoupling strategy.

[7]: This paper presents a performance comparison of a cascode GaN HEMT and a Si MOSFET rated at 600V which are used in a 1 kW three-phase inverter. The advantages and challenges of using GaN transistors in a motor drive application are discussed. Thermal simulations of a GaN and Si based inverter have been performed and experimental results of the switching performance and inverter efficiency using both device technologies are presented. The results show the high potential of GaN power devices in a motor drive application.

[8] : This paper presents a simple dead-time compensation method for a three phase PWM inverter based on the measured pole voltage using enhanced capture (eCAP) module usually embedded in a digital signal processor (DSP). The information of the inverter pole voltages can be employed to compensate the voltage difference between commanded voltage and actual output voltage of the PWM inverter. Because the method does not rely on any other information except for the measured switching instants of each phase of the inverter, it can be easily accommodated into the low cost drive system where accurate and instantaneous measurement of the phase current is not available. The difference can be added at the next sampling time of the switching period of the PWM and could be updated after one sampling period due to the digital sampling delay. These total two sampling periods delay would degrade the performance of the dead-time compensation. To enhance the performance, a PI regulator is employed to nullify the difference in controlled manner. The effectiveness of the proposed compensation methods has been verified through the experimental results. Through the proposed compensation method, the 5th and 7th harmonic currents are reduced by 85% and 70%, respectively.

[9] : GaN power devices offer great performance improvements compared to Si transistors. The lower conduction and switching losses of GaN transistors enable to build high efficiency power converters with high switching frequencies. An increase of the PWM frequency has many advantages in motor drive applications like reduced motor current ripple, lower motor losses and reduced filter size and cost. This paper presents the evaluation of a normally-off 650 V, 30 A GaN transistor in a motor drive application. The switching performance of the GaN HEMT is investigated by using a double pulse tester. Furthermore, design and experimental results of a high efficiency 1.5kW three-phase-inverter with sine-output filter and a PWM frequency of 100 kHz are shown. The GaN inverter with sine-output filter achieves 97% efficiency.

[10] : With the rapid development of wide bandgap power transistor technology, the latest gallium-nitride based power transistors are able to be used as the main switches in the high power (≥10 kW) conversion systems. In order to achieve the desired high efficiency and higher power density successfully, the entire GaN based power conversion system needs to take multiple considerations into the design stage. In this paper, a three-phase inverter is used as the example to explain those considerations in detail, including the critical component selection, the system physical layout, the cooling system design, the protection functions design and the EMI control. Based on the proposed design methodology, a 10 kW GaN-based three phase inverter is developed with 98.8% peak efficiency with 0.7 liter box volume.

[11] This paper proposes a decoupling control method for high-performance drive of permanent magnet synchronous motors (PMSMs). The conventional decoupling schemes proposed for removing coupling effects on d-q current regulation have the limited performance because the cross-coupling inductances caused by asymmetric structure and saturation are not considered. Those inductances may degrade the decoupling performance and even make the current control unstable by inducing the additional coupling voltages. Therefore, in this paper, a new voltage model including the cross-coupling inductances is developed and the compensation voltages for decoupling based on the model are calculated. The performance of the proposed decoupling method is verified by experimental results.

[12] : The controller design of servo drives for bandwidth improvement will presented in this paper. The delay issues caused by calculation, filter and PWM generation, etc. are addressed. The controllers of current loop, speed loop and position loop are designed considering the delay and phase margin. Experimental results show the bandwidth for current, speed and position loops of servo drives are significantly improved as compared to those using conventional methods. For the servo drives with switching frequency of 20 kHz, as compared to traditional design method, the achievable control bandwidth for the presented method of position control loop is improved from 20 Hz to 116 Hz.

[13] : Increased productivity in industrial processes can be achieved by dynamic and accurate positioning of servo drives. Therefore, improvement of servo drive dynamics using latest technologies in the key components such as inverter, control system and position measuring device are investigated. Using Gallium Nitride (GaN) or Silicon Carbide (SiC) semiconductors for motor inverters enables energy efficient operation up to pulse width modulation (PWM) frequencies of 500kHz. This allows motor filters with small component sizes. As a result, high motor efficiency, low torque ripple, high control bandwidth and almost ideal sinusoidal output voltages are achieved. Experiments on a 200kHz Gallium Nitride inverter with sine wave motor filter show a current control loop bandwidth of 3.2kHz and almost ideal sinusoidal phase voltages. The achieved bandwidths of the speed and position control loops are 318 Hz and 106Hz, respectively.

[14] : The medium power rating two-level three phase voltage source inverter is among the most popular power conversion systems. The typical switching frequency of the commercial medium power rating inverter, however, is limited to tens of kHz. By increasing the switching frequency and using emerging gallium-nitride devices, the size of the overall system can be greatly reduced. This paper begins by reviewing all commercially available GaN power transistors and their package technologies. The GS66516T device from GaN Systems is selected due to its suitable ratings and superior package performance. Then, a half-bridge structure is designed for this device to achieve low parasitic inductance and strong cooling capability at the same time. The dynamic characterization results of this 650V/60A Enhancement-mode GaN transistor are extracted with the proposed half-bridge structure. A gate drive circuit with comprehensive protection function is integrated. Based on the proposed phase-leg structure, a 10 kW three phase inverter prototype is built and the experimental waveform is shown at the end.

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