CHAPTER 6

CONCLUSIONS

In this dissertation, first an equivalent dc brush motor model is proposed for the concerned three-phase PMBLDC motors. Then, a simple linear relationship between the electromagnetic torque and the equivalent armature current of the PMBLDC motor is derived. Through the linear torque control equation, instead of using the complicated control of three-phase currents, only one control variable, i.e., the equivalent armature current needs to be controlled to drive the PMBLDC motor. This will simplify greatly the PMBLDC motor control.

Second, instead of using the dual mode control, a novel tri-mode control as well as the sensing and synthesizing of the equivalent armature current of the PMBLDC motor is proposed. By properly integrating the equivalent armature current sensing and synthesizing scheme with the PWM control, one can achieve complete motor current information and the hardware implementation of the proposed PMBLDC motor drive can be made rather compact, and enable further integration into a single chip to reduce size, weight, cost and enhance current regulation performance. Moreover, the commutation electromagnetic torque ripples can automatically be reduced for all speed range.

Third, a new control strategy of phase-locked loop assisted adjustable speed controller of PMBLDC motors is proposed. The PI type PLL control structure makes the controller possess fast transient response, no limitation of lock range and the high speed control accuracy. Moreover, by using a robust internal reference model control, the closed form expressions of k_P and k_I parameters of the PI controller are also derived. These k_P and k_I expressions render the design of the drive rather easy. Also, a stability criterion for the drive system is presented for ensuring the stable phase tracking.

Control system has been well designed and integrated. As well, a prototype of the proposed controller is constructed and applied to an industrial blower to verify the feasibility and effectiveness of the proposed adjustable speed drive. Experimental results show that both accurate steady state and fast transient speed response can be achieved. Moreover, a quite uniform equivalent armature current waveforms, which can greatly reduce the mechanical vibration noise, can be obtained easily. Compared with conventional dual mode control which has to switch to the PLL mode under steady state, the proposed control can provide a unified and smooth control under both transient and steady state conditions. It is seen that the proposed PLL assisted adjustable speed strategy is rather attractive for practical applications.

In addition, compared the power consumption between the original industrial blower system driven by a traditional three-phase induction motor system and that driven by the self-designed PMBLDC motor system, one can see that the proposed drive system can saving the power consumption by 20% at rated speed (1100rpm), 60% at 550rpm and more than 80% at 380rpm, as well reduce the total volume and weight by 30% and 57% respectively.

This dissertation has established a foundation of modeling and control of PMBLDC motors. However, due to limitation of time there still exist some possible directions worthy of further study, which are listed as follows:

(a) First for practical application, the control circuit of the proposed drive is attractive to be integrated in a single chip to reduce size, weight, cost and enhance the performance of the drive. In other words, further development an ASIC remains to be done.

(b) Second, although the proposed drive is mainly developed for the industrial blower application, however, it can be extended to servo applications by considering two-degree-of-freedom control structure to achieve faster tracking capability.

(c) Third, for compressor applications, it is worth to develop a corresponding Hall-effect sensorless drive version.

(d) Forth, from the view point of motor design, it is also worth to investigate the possible motor slot structure such that the motor itself can serve as a sensor for speed sensorless control.

(e) Finally, as far as the torque ripple reduction is concerned the proposed drive solves the

problem by controlling the equivalent armature current. On the other hand, one can also solve the problem by improving the waveform of the back emf of the PMBLDC motor by using more innovative motor design.