Power Electronics

FOREWORD

Power electronics is an important area of Electrical Engineering. It broadly deals with controlling the flow of electrical power using electronic switching devices. The amount of power handled may vary from a few watts to megawatts. The papers included in this Special Issue are selected out of a pool of seventy-six papers presented at the National Power Electronics Conference (NPEC) 2007, held at the Indian Institute of Science, Bangalore during 17–19 December 2007. They cover a wide spectrum of areas from power supplies to power system applications.

The first four papers are related to power converter topologies. Lakshminarasamma & Ramanarayanan describe the modelling and design of a family of soft transition converters, while Bhardwaj *et al* discuss reduction of losses and retention of zero voltage switching (ZVS) in a full bridge converter. These papers are mainly directed towards switch mode power supplies, where the focus is on increasing the switching frequency, thereby reducing size and weight. In the process, a whole gamut of issues such as increased circuit complexity and component count, shaping of the switching loci of the devices to reduce losses, losses in the additional circuit elements and suitable control algorithm have to be addressed. This has led to a very fertile field for research. The paper by Borghate *et al* addresses the design of electronic ballasts for fluorescent lights. Because of the vast number of lights in use, every improvement in performance through the application of power electronics will have widespread impact on the power distribution system. The design of ballasts, therefore, continues to be an interesting topic for research. The fourth paper in the area of converter topologies, by Kedarnath & Vasudevan, describes a circuit topology for an interesting application viz. electromagnetic methods for geophysical exploration. The work is illustrative of the fact that in many areas other than transmission and utilization of electrical power, there are requirements for the design of special electrical power sources. Power electronics plays an important role here.

Electrical motor drives form one of the major application areas of power electronics. The two main concerns here are; a) development of suitable converter topologies and b) the control of the power converter and the drive. The power ratings vary over a wide range, from a few tens of watts in consumer applications to multi megawatt industrial drives. Solutions have to be appropriate according to the power level and therefore control of motor drives is one of the primary areas of research in power electronics. There are five papers appearing in this area. Behera & Das describe an improvement in the control technique for induction motors known as Direct Torque Control (DTC). The basic DTC technique uses hysteresis controllers for the motor torque and flux to determine the next switching state of the inverter driving the motor. The authors have proposed the addition of a dither signal in the hysteresis blocks in order to reduce the torque ripple and acoustic noise. Nandi has analysed the effect of time and space harmonics on sensorless control schemes for slip ring induction motors and proposed improvements for obtaining better speed estimation. Murugan *et al* describe the engineering development of a brushless DC (BLDC) motor drive for power assisted steering

in vehicles. In traction and automotive applications, other than the main propulsion drive itself, there are a number of auxiliary applications requiring electrical control and activation. The paper by Murugan *et al* is a good example of this. Sivaprasad *et al* consider the vector control of a high power unity power factor AC–DC front end converter for inverter-fed drives. Such a converter acquires importance because it results in almost ideal features such as sinusoidal line current at unity displacement factor, regulated DC output voltage, regeneration of power when the drive is operating in the braking mode and fast dynamic response. The authors specially consider the issues of high power units where the line side inductance is very low. In the last paper in this area, Ramachandran *et al* have described a method for identification of the current flowing through the motor bearings in an inverter-fed drive and have proposed a circuit for minimizing it. There have been numerous reports in the literature on the deleterious effects of such bearing currents in drives and the paper is therefore quite topical.

The use of power electronic converters in power systems can result in improvement in several aspects of system operation. High Voltage Direct Current (HVDC) power transmission and Static Var Compensators are two applications which are widespread today. The use of active filters, based on switching power converters, to improve power quality at distribution and subtransmission levels is also well known. The concept of Flexible AC Transmission Systems (FACTS) has been proposed and awaits the economical development of high voltage high power voltage source converters for practical use. The present volume contains two papers relating to power system applications. Surendra Kumar & Sensarma have proposed multi band active filters for harmonic mitigation. Meghwani & Kulkarni report the development of a real time model for Static Synchronous Series Compensator (SSSC). Such real time models are extremely important, as they can be included in real time simulation of systems to evolve control schemes for the converters as well as to study the effect on the power system.

In view of the control possibilities offered by the use of power converters and the newly emerging applications, there has been a lot of interest in having a re-look at the design of electrical machines. Sinha *et al* describe a differential induction machine with two shafts, which can be a new solution for the differential drive in electric vehicles. More *et al* report the design of full pitch windings for doubly salient flux reversal machines.

The metallurgical industry has given rise to much work on the development of power electronic converters for applications like rolling mill drives, arc furnaces, electrolysis plants, induction heating and welding. An important application which has emerged recently is that of electromagnetic stirring in the processing of molten aluminium. Madhavan & Ramanarayanan present numerical simulations as well as experimental measurements to show the effect of secondary conductor geometries—such as solid cylinder and annular tube—on the stirring of molten aluminium in an electromagnetic stirrer.

The paper by Sharma *et al* describes an interesting and unusual application, where a polyphase motor action is obtained using shape memory alloy based actuators. This work is aimed at mechatronic actuators.

Although power electronics generally deals with switching power converters, the work by Nutheti *et al* describing the development of a high voltage high power Operational Amplifier (opamp) belongs naturally in this volume. The unusual levels of supply voltage of ± 200 V—and output current of 200 mA—classify the resulting device as a truly power electronic element.

The contents of this volume thus encompass a wide spectrum of research. It is hoped that it will be of interest to a large audience, consisting not only of power electronics professionals but also scientists and engineers working in related areas.

I would like to place on record my appreciation of the hard work put in by my colleagues Dr G Narayanan and Dr Vinod John in organizing the entire process of reviewing and overseeing the corrections. Their devoted efforts have made the production of this Special Issue on Power Electronics a pleasant task.

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Guest Editor