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# Recent advances in permanent magnet brushless DC motors

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**Abstract.** This paper deals with the latest developments in Permanent Magnet Brushless DC (PMBLDC) motor drives. A comprehensive account of the state-of-the-art on types of construction of the motor, closed loop controllers in position, speed and current/torque control and recent trends in inverters, sensors etc. are given. Techniques for mechanical sensors elimination are discussed in detail. Special efforts made to reduce torque ripples, noise and vibrations are described. The impact of microelectronics through integrated chips used in the control of PMBLDC motor drives is given. The increasing applications of this drive due to improved performance and its cost reduction are also enlisted.

**Keywords.** PMBLDC motor; sensors; controllers; sensorless operation; torque pulsations.

## 1. Introduction

Permanent Magnet Brushless DC (PMBLDC) motors are increasingly being used in a wide spectrum of applications such as domestic equipments, automobiles, information technology equipment, industries, public life appliances, transportation, aerospace, defence equipment, power tools, toys, vision and sound equipment and medical and health care equipment ranging from microwatts to megawatts [1–24]. It has become possible because of their superior performance in terms of high efficiency, fast response, light weight, precise and accurate control, high reliability, maintenance free operation, brushless construction, high power density and reduced size. Recent developments in PMBLDC motor technology in terms of availability of high performance rare earth PM materials, varying motor constructions such as axial field, radial field, package type, rectangular fed, sine fed motors, improved sensor technology, fast semiconductor modules, low cost high performance microelectronics devices, new control philosophy such as robust, adaptive, fuzzy, neural AI based controllers, have been a boon to their widespread use in the large speed ranges from few revolutions to several thousand revolutions per minute (rpm). They have been proven most suitable for position control in machine tools, robotics and high

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