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Three-Dimensional Magnetic Sensors in BiCMOS Technology

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Three-dimensional magnetic field sensors are being applied in many fields. This paper presents many designs of three-dimensional magnetic field sensors in BiCMOS technology, their advantages and applications. Since the cross-axis sensitivities among the various components of the magnetic field have hindered development of a 3-dimensional integrated magnetic sensor, in this paper, it is demonstrated experimentally that complete elimination of the cross-sensitivity is possible when a magnetic sensor is implemented in standard BiCMOS technology. A compact device structure is then designed by exploring the merged BiCMOS technology to detect the three components of the magnetic field vector by merging a split-collector magnetotransistor and a split-drain MOSFET. The detailed design of the merged structure by common diffusion, along with the peripheral high gain transduction circuits, is presented. An 8-by-8 monolithic array is then designed and simulated. An application of the array structure is also discussed.

1. Introduction

Magnetic field sensors have recently employed various device configurations as a means of detecting the presence of a magnetic field vector. These include vertical magnetotransistors,[1,2] lateral magnetotransistors,[3–6] Hall devices,[7–9] split-drain MAGFETs[10–12] and suppressed-side-injection magnetotransistors. Each type has both advantages and disadvantages for 3-dimensional applications. The major limitations remain because of cross-axis sensitivities. A 3-D vertical Hall magnetic field sensor was reported recently,[9] where the cross-sensitivity between X and Z