FROM HALL EFFECT TO TMR

By Allegro MicroSystems

ABSTRACT

This paper compares legacy Hall-effect technology to xMR technology, specifically tunnel magnetoresistance (TMR) from Allegro MicroSystems.

INTRODUCTION

Historically, there have been many systems to transduce a magnetic field to a proportional voltage. These sensors vary by industry application and include magnetic-encoder, e-compass, absolute angle-sensor, simple on/off-switch, and current sensing.

The most popular of these were Hall-effect sensors, discovered by Edwin Hall in 1879. Yet, after more than a century of development, these legacy sensors have finally reached their limits. Today, system designers require new technologies with improved power consumption, sensitivity, accuracy, and cost.

Increasingly, the solution is TMR technology, the natural evolution of older technologies like giant magnetoresistance (GMR) and anisotropic magnetoresistance (AMR). This paper provides a high-level introduction to these different technologies and a look at the Allegro TMR solution.

THE PHYSICS

Hall Effect

A Hall-effect demonstrator requires a thin plate of conductive material, carrying current (I) generated by a DC voltage supply and a voltmeter connected to the sides of the conductive plate, as illustrated in Figure 1.

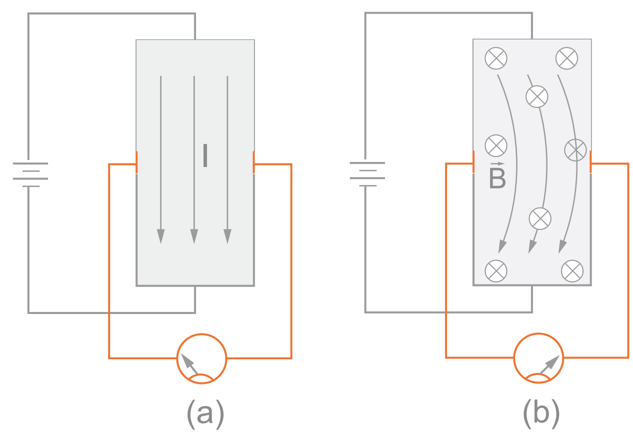

Figure 1: The Hall Effect in a Thin Plate

When a magnetic field is not present, the voltmeter should read 0 V, as shown in Figure 1 (a). However, when a magnetic field—perpendicular to the current flow—is applied to the plate, a small voltage appears across the plate, which can be measured by the voltmeter, as illustrated in Figure 1 (b).

The separation of charge establishes an electric field that opposes the migration of further charge, so a steady electrical potential is established for as long as the electrons are

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