Chapter 1

Hall Effect Sensing

Introduction

The Hall effect has been known for over one hundred years, but has only been put to noticeable use in the last three decades. The first practical application (outside of laboratory experiments) was in the 1950s as a microwave power sensor. With the mass production of semiconductors, it became feasible to use the Hall effect in high volume products. MICRO SWITCH Sensing and Control revolutionized the keyboard industry in 1968 by introducing the first solid state keyboard using the Hall effect. For the first time, a Hall effect sensing element and its associated electronics were combined in a single integrated circuit. Today, Hall effect devices are included in many products, ranging from computers to sewing machines, automobiles to aircraft, and machine tools to medical equipment.

Hall effect sensors

The Hall effect is an ideal sensing technology. The Hall element is constructed from a thin sheet of conductive material with output connections perpendicular to the direction of current flow. When subjected to a magnetic field, it responds with an output voltage proportional to the magnetic field strength. The voltage output is very small (μV) and requires additional electronics to achieve useful voltage levels. When the Hall element is combined with the associated electronics, it forms a Hall effect sensor. The heart of every MICRO SWITCH Hall effect device is the integrated circuit chip that contains the Hall element and the signal conditioning electronics.

Although the Hall effect sensor is a magnetic field sensor, it can be used as the principle component in many other types of sensing devices (current, temperature, pressure, position, etc.).

Hall effect sensors can be applied in many types of sensing devices. If the quantity (parameter) to be sensed incorporates or can incorporate a magnetic field, a Hall sensor will perform the task. Figure 1-1 shows a block diagram of a sensing device that uses the Hall effect.

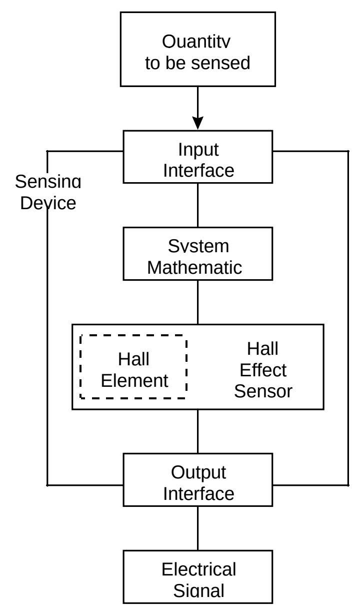

Figure 1-1 General sensor based on the Hall effect

In this generalized sensing device, the Hall sensor senses the field produced by the magnetic system. The magnetic system responds to the physical quantity to be sensed (temperature, pressure, position, etc.) through the input interface. The output interface converts the electrical signal from the Hall sensor to a signal that meets the requirements of the application. The four blocks contained within the sensing device (Figure 1-1) will be examined in detail in the following chapters.

Why use the Hall effect?

The reasons for using a particular technology or sensor vary according to the application. Cost, performance and availability are always considerations. The features and benefits of a given technology are factors that should be weighed along with the specific requirements of the application in making this decision.

General features of Hall effect based sensing devices are:

- True solid state
- Long life (30 billion operations in a continuing keyboard module test program)
- High speed operation - over 100 kHz possible
- Operates with stationary input (zero speed)
- No moving parts
- Logic compatible input and output
- Broad temperature range (-40 to +150°C)
- Highly repeatable operation

Using this manual

This manual may be considered as two parts: Chapters 2 through 5 present the basic information needed to apply Hall effect devices. Chapter 6 brings this information together and relates it to the design and application of the Hall effect sensing systems.

Chapter 2, Hall effect sensors. Introduces the theory of operation and relates it to the Hall effect sensors. Both digital and analog sensors are discussed and their characteristics are examined. This chapter describes what a Hall effect sensor is and how it is specified.

Chapter 3, Magnetic considerations. Covers magnetism and magnets as they relate to the input of a Hall effect device. Various magnetic systems for actuating a sensor are examined in detail.

Chapter 4, Electrical considerations. Discusses the output of a Hall effect device. Electrical specifications as well as various interface circuits are examined. These three chapters (2, 3, and 4) provide the nucleus for applying Hall effect technology.

Chapter 5, Sensing devices based on the Hall effect. These devices combine both a magnetic system and a Hall effect sensor into a single package. The chapter includes vane operated position sensors, current sensors, gear tooth sensors and magnetically-operated solid state switches. The principles of operation and how these sensors are specified are examined.

Chapter 6, Applying Hall effect sensors. This chapter presents procedures that take the designer from an objective (to sense some physical parameter) through detailed sensor design. This chapter brings together the Hall sensor (Chapter 2), its input (Chapter 3), and its output (Chapter 4).

Chapter 7, Application concepts. This is an idea chapter. It presents a number of ways to use Hall effect sensors to perform a sensing function. This chapter cannot by its nature be all inclusive, but should stimulate ideas on the many additional ways Hall effect technology can be applied.

This manual may be used in a number of ways. For a complete background regarding the application of Hall effect sensors, start with Chapter 1 and read straight through. If a sensing application exists and to determine the applicability of the Hall effect, Chapter 7 might be a good place to start. If a concept exists and the designer is familiar with Hall effect sensors, start with Chapter 6 and refer back to various chapters as the need arises.