LINEAR POSITION SENSORS

Theory and Application

DAVID S. NYCE

WILEY-INTERSCIENCE

A JOHN WILEY & SONS, INC., PUBLICATION

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To Gwen, and our children Timothy, Christopher, and Megan,
whose love and support helped me complete this project

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PREFACE

Society and industry worldwide continue to increase their reliance on the availability of accurate and current measurement information. Timely access to this information is critical to effectively meet the indication and control requirements of industrial processes, manufacturing equipment, household appliances, onboard automotive systems, and consumer products. A variety of technologies are used to address the specific sensing parameters and configurations needed to meet these requirements.

Sensors are used in cars to measure many safety- and performance-related parameters, including throttle position, temperature, composition of the exhaust gas, suspension height, pedal position, transmission gear position, and vehicle acceleration. In clothes-washing machines, sensors measure water level and temperature, load size, and drum position variation. Industrial process machinery requires the measurement of position, velocity, and acceleration, in addition to chemical composition, process pressure, temperature, and so on. Position measurement comprises a large portion of the worldwide requirement for sensors. In this book we explain the theory and application of the technologies used in sensors and transducers for the measurement of linear position.

There is often some hesitation in selecting the proper word, *sensor* or *transducer*, since the meanings of the terms are somewhat overlapping in normal use. In Chapter 1 we present working definitions of these and other, sometimes confusing, terms used in the field of sensing technology. In Chapter 2 we explain how the performance of linear position transducers is specified. In the remaining chapters we present the theory supporting an understanding of the prominent technologies in use in linear position transducer products. Application guidance and examples are included.

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CHAPTER 1

SENSOR DEFINITIONS AND CONVENTIONS

1.1 IS IT A SENSOR OR A TRANSDUCER?

A *transducer* is generally defined as a device that converts a signal from one physical form to a corresponding signal having a different physical form [29, p. 2]. Energy can be converted from one form into another for the purpose of transmitting power or information. Mechanical energy can be converted into electrical energy, or one form of mechanical energy can be converted into another form of mechanical energy. Examples of transducers include a loudspeaker, which converts an electrical input into an audio wave output; a microphone, which converts an audio wave input into an electrical output; and a stepper motor, which converts an electrical input into a rotary position change.

A *sensor* is generally defined as an input device that provides a usable output in response to a specific physical quantity input. The physical quantity input that is to be measured, called the *measurand*, affects the sensor in a way that causes a response represented in the output. The output of many modern sensors is an electrical signal, but alternatively, could be a motion, pressure, flow, or other usable type of output. Some examples of sensors include a thermocouple pair, which converts a temperature difference into an electrical output; a pressure sensing diaphragm, which converts a fluid pressure into a force or position change; and a linear variable differential transformer (LVDT), which converts a position into an electrical output.

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