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Direct interface circuits for sensors

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Abstract: This chapter discusses the direct connection of analogue sensors to digital systems without using any analogue circuit in the signal path. It first reviews the operating principle of analogue sensors (mainly, resistive and capacitive sensors) and digital systems (basically, microcontrollers). It then explains how to connect different sensor topologies to a microcontroller to build a direct interface circuit. Finally, it discusses some applications using commercial devices.

Key words: sensor electronic interface, microcontroller, resistive sensor, capacitive sensor.

2.1 Introduction

Just as human beings acquire information on their environment through their senses and process such information using their brain, electronic systems try to do the same by means of sensors and processing digital devices such as microcontrollers (μC) or microprocessors (μP). Nowadays, sensors and processing devices have become essential for the smooth running of our lives and they are present in many fields: industrial, automobiles, aircraft, medical devices, consumer electronics and home appliances, among others.

The classic block diagram of a sensor electronic interface is shown in Fig. 2.1a (Pallàs-Areny and Webster, 2001). First, information about the measurand (e.g., temperature) is converted to the electrical domain by means of the sensor, which usually provides an analogue electrical signal of low amplitude that carries some noise. Afterwards, the signal conditioning circuit, which generally relies on operational amplifiers, performs some or all of the following tasks in the analogue domain: sensor output-to-voltage conversion, amplification, filtering, linearization and/or demodulation. The resulting analogue signal is then digitized via an analogue-to-digital converter (ADC). Finally, a digital system (e.g., a μC) acquires, stores, processes, controls, communicates (to other devices or systems) and/or displays the digital value with information about the measurand.

- Gaitán-Pitre, J.E. and Pallàs-Areny, R. (Universitat Politècnica de Catalunya, Castelldefels, Spain), who undertake research on direct interface circuits based on the charge-transfer technique.
- Kokolanski, Z. and Gavrovski, C. (University Ss. Cyril and Methodius, Skopje, Macedonia), who propose novel techniques to reduce the uncertainty of measurement (Kokolanski *et al.*, 2011).
- Pelegrí-Sebastiá, J. (Universidad Politécnica de Valencia, Gandia, Spain), who uses direct interface circuits to measure low-cost, low-power sensors.
- Sifuentes, E. (Universidad Autónoma de Ciudad Juárez, Juárez, Mexico), who undertakes research on direct interface circuits for vehicle detection.
- Vidal-Verdú, F. (University of Malaga, Malaga, Spain), who uses FPGAs to build direct interface circuits for tactile sensors.
- Yurish, S. (Technology Assistance BCN2010, Barcelona, Spain), who designs ASSPs based on the operating principle explained throughout this chapter.

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