Interfacing sensors to microcontrollers: a direct approach

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2.1 Introduction

Just as human beings acquire information from 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 everywhere: industry, automobiles, aircrafts, medical devices, consumer electronics, and home appliances, among others.

The classic block diagram of a sensor electronic interface is shown in Fig. 2.1(a) (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 analog electrical signal of low amplitude that carries some noise. Afterward, the signal conditioning circuit, which generally relies on operational amplifiers, performs some or all of the following tasks in the analog domain: sensor output-to-voltage conversion, amplification, filtering, linearization, and/or demodulation. The resulting analog signal is then digitized via an analog-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.

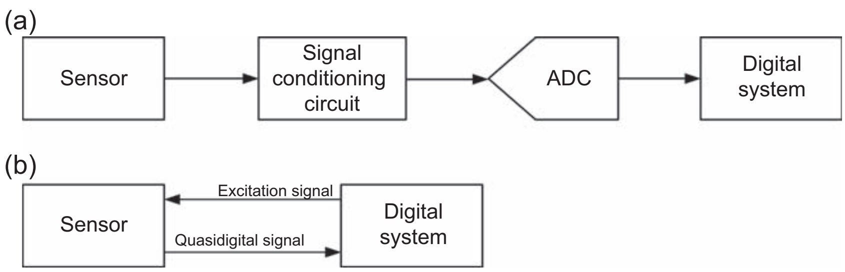

Figure 2.1 (a) Classic block diagram of a sensor electronic interface, (b) direct interface circuit.

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- *Designing an ASIC or ASSP*: The design of an application-specific integrated circuit (ASIC) or an application-specific standard processor (ASSP) could also be of interest to have a digital system optimized in terms of power and embedded resources. Actually, a commercial ASSP known as USTI (which means universal sensors and transducers interface) has been recently designed. This chip is able to measure resistive sensors (Yurish, 2009a, 2011) and capacitive sensors (Yurish, 2009b) using the operating principle explained in Section 2.4.

Sources of further information and advice

Researchers worldwide are involved in the field of direct interface circuits. Some of these researchers, their affiliation, and a brief description of their work are indicated below.

- Courbat, J. and Briand, D. (Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland), who use direct interface circuits to measure low-cost low-power sensors.
- Czaja, Z. (Gdansk University of Technology, Gdansk, Poland), who proposes direct interface circuits for impedance sensors.
- 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.
- George, B. (Indian Institute of Technology Madras, Chennai, India), who proposes direct interface circuits for different types of analog sensors.
- Kokolanski, Z. (University Ss. Cyril and Methodius, Skopje, Macedonia), who designs and analyses direct interface circuits for inductive sensors.
- Pelegrí-Sebastiá, J. (Universidad Politécnica de Valencia, Gandia, Spain), who uses direct interface circuits to measure low-cost, low-power sensors.
- Sifuentes, E. and González-Landaeta, R. (Universidad Autónoma de Ciudad Juárez, Ciudad Juárez, Mexico), who undertake research on direct interface circuits for vehicle detection and for the measurement of biomedical signals.
- 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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