

Chapter 2

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Introduction

Data acquisition is the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer. Data acquisition systems, abbreviated by the acronyms DAS or DAQ, typically convert analogue waveforms into digital values for processing. The components of data acquisition systems include:

- Transducer is a device converts one type of energy to another (electrical) for various purposes including measurement or information transfer.
- Signal conditioning circuitry, to convert sensor signals into a form that can be converted to digital values.
- Analog-to-digital converters, to convert conditioned sensor signals to digital values.



Choosing a Sensor

Criteria to choose a Sensor



Selection Of Sensors

- The first step in the selection procedure is to clearly define the nature of quantity under measurement, and know the range of magnitudes and frequencies that it is expected to show.
- Next step will be to examine the available Sensor principles for measurement of desired quantity. The type of sensor selected must be compatible with the type and range of the quantity to be measured and the output device.
- In case one or more sensing principles are capable of generating a satisfactory signal, decision is to be taken whether to employ a commercially available sensor or build a suitable sensor.
- If the sensors are available in the market at a suitable price, the choice will probably be to purchase one of them, otherwise own sensor will have to be designed, built and calibrated.

Input devices

- Push buttons (PB)
- Switches (SPDT, SPST)
- Keypads
- Thumbwheel switch









Relay











RTD and **Thermistor**

- Resistance temperature device (RTD)
- Thermistors (Thermal Resistor)
 - NTC (Negative Temperature Coefficient)
 - PTC (Positive Temperature Coefficient)



RTD





Thermistors



Thermocouple

Thermocouple: transform a temperature difference to a voltage difference



Resistive Displacement Sensor

- A common requirement in industrial measurement and control work is to be able to sense the position of an object, or the distance it has moved.
- One type of displacement transducer uses a resistance element with a sliding contact or wiper linked to the object being monitored. Thus, the resistance between the slider and one end of the resistance element depends on the position of the object.
- The output voltage V₀ is a certain fraction of V_T, depending on the position of the wiper:

$$\frac{V_0}{V_T} = \frac{R_2}{R_1 + R_2}$$



A displacement transducer with a shaft stroke of 3.0 cm. is applied in the circuit of Figure above. The total resistance of the potentiometer is 5 k, and the applied voltage VT=5.0V. When the wiper is 0.9 cm. from B, what is the value of the output voltage V0?



Photo-resistor

- Light sensitive variable resistors.
- Its resistance depends on the intensity of light upon it.
 - Under dark condition, resistance is quite high (M Ω :called dark resistance).
 - Under bright condition, resistance is lowered (few hundred Ω).
- Response time:
 - When a photo-resistor is exposed to light, it takes a few milliseconds, before it lowers its resistance.
 - When a photo-resistor experiences removal of light, it may take a few seconds to return to its dark resistance.







Photo Detector

- Uses emitter and detector photo diode pair
- With no obstruction detector is high
- When an object blocks the light the detector is low
- Advantages
 - Simple to interface
 - Inexpensive
 - Reliable











Proximity Sensor

- A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact.
- A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target.
- Different proximity sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target.
- Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object.







Optical Encoder

- Encoder wheel for angular measurements.(Computer mouse with a ball)
- Converts motion into a series of digital pulses.
- By counting a single bit or a set of bits the pulses can be converted into relative or absolute position measurements.
- Rotational encoders are manufactured in two basic forms: the absolute encoder and the incremental encoder (allows measurement of relative position of the shaft).
- Angular Speed S = Output frequency / number of holes (Revolution per second)



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Shaft Encoder











Basic Combinational Logic

- Logic Gates
- Function Minimization using Karnough Maps (K-Maps)
- Multiplexers (Mux)

