Sensors

A device that provides measurements of a physical process. Many sensors are transducers, devices that convert energy from one form to another.

Examples:

- Pressure sensors - voltage is proportional to pressure
- Infrared sensors - on if IR achieves critical threshold
- Digital cameras - convert light intensity to digital value
Sensor Types

There are many different types of sensors and they can be broadly categorized by either their application or their mechanism.

By Mechanism

Optical and infrared
Radio-frequency
Magnetic
Inductive/Capacitive
Tactile
Acoustic and ultrasonic
Humidity
Mechanical (vibration, switching)
Temperature
## Sensors Types

### By Application

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Sensing

- Sensors can be either analog or digital depending on the type of signal produced.
- Analog sensors transmit data in the voltage of the signal provided. It is also possible to transmit data via the frequency, but I can’t think of any.
- Digital sensors transmit data as zeros and ones which could be binary value or simple on/off signals. It is also possible to provide data via the length of time between pulses.
- The issues in interfacing sensors are:
  - Interfacing power levels.
  - Possibly powering the sensor.
  - Data conversion.
Interfacing

Sensor → Analog Signal Conditioning → Amplify → Sample and Hold → Analog/Digital Conversion

Digital Device → Digital Signal Conditioning

Relay or Actuator → Digital Signal Conditioning

Actuator → Analog Signal Conditioning → Analog/Digital Conversion

Controller
Signal Conditioning

Most microcontrollers use TTL (transistor-transistor logic) which means that the voltage levels are nominally +5 volts and 0 volts for high and low, but the actual range might be 0-0.4 v is low and 2.4 to 5 v is high. These numbers vary depending on the TTL family. The families are standard, Schottky (fast), low-power Schottky (LS) (fast and low-power), Advanced Schottky (AS) and Advanced low-power Schottky (ALS). In addition, CMOS (Complementary Metal Oxide Semiconductor) components use a different structure to get low power, wider operating voltage and reduced noise. However, they have longer propagation times and poor high-frequency behavior.

The bottom line for interfacing is that the electronic logic between the sensor and the controller may not match up, so some form of signal conditioning may be required. Also, long distances may require amplification or repeating to achieve a useable signal.
Digital Signal Conditioning

Typical controller logic is low-power Shottkey so you can expect:

- The maximum sink current is about 24 mA.
- The maximum source current is about 2.4 mA.
- High-level output voltage ≥ 2.4 v minimum.
- Low-level output voltage ≤ 0.5 v minimum.

So if you are going to interface to such a device, you need to insure that the signals are properly conditioned.
Examples of Interfacing

The following are examples of interfacing that demonstrate the use of different methods for different circuits and the justification for the designs.
If the controller can source 15 mA, and a typical LED will operate on voltages as low as 1.4 v and 15 mA. Using Ohm’s Law, $V = IR$, we need to find a resistor size to place in the line to make sure that the current from the controller is less than 15-20 mA.

$$R = \frac{V}{I} = \frac{5}{15mA} = 330\, \text{ohms}$$

To be on the safe side, 470 Ohms is specified.
Controlling an LED with Source Current

If the controller can sink 20 mA we know from before that 330 Ohms is safe.