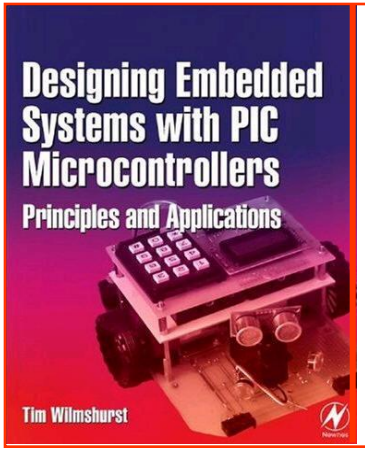
Sensors and actuators



For further information and background, read pages 184-198.

Sensors

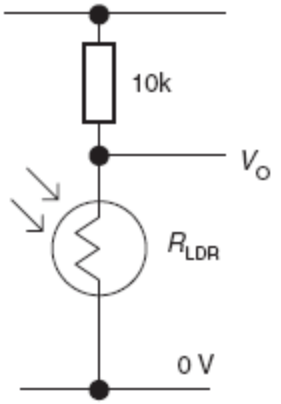
- Variety of sensors are available – Ex: electromechanical , optical , ultrasonic
- Smart , intelligent sensors
    - Integrated onto IC having on-chip signal processing
- Based on physical phenomenon that leads to conversion of physical variable to electrical sometimes through intermediate variable

Micro switch

- Mechanical position sensing
- Single pole, double throw switch, lever or roller for actuation
- Interfaced like normal toggle switch
- In industrial applications precautions to be taken to minimize electrical interference

Light dependent resistors

- LDR is made from a piece of exposed semiconductor material
- When light falls hole-electron pairs created in material and improves conductivity
- When light removed hole-electron pair recombine and conductivity falls
- As illumination increases the LDR resistance falls
- Can be connected to ADC



Illumination (lux)	R_{LDR} (Ω)	V_O
Dark	2M	5.00
10	9k	2.36
1000	400	0.19

8.13 The NORP12 LDR connected in a potential divider, with indicative output values

Optical object sensing

- To sense objects and surfaces
- Sensed by either by breaking or reflecting the light beam
- consists of an infrared LED and phototransistor mounted side by side in the same plastic package.
- The package material allows infrared light to pass, but filters ambient visible light.
- When a reflective surface is placed at a suitable distance in front of the sensor, some of the emitted light is reflected back to the phototransistor, which then conducts.
- If the sensor is connected , then the circuit output *VO is at Logic 1*
- When no reflection occurs and goes to Logic 0 if a reflective surface is present.
- Resistor values are dependent on sensor characteristics, the ones given here being indicative.
- The distance from sensor to reflective surface is critical in many such sensors, with preferred distances around 3mm being common.

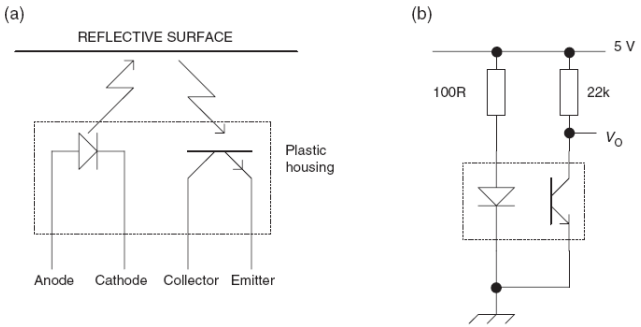


Figure 8.14 The reflective optical sensor. (a) Principle of operation. (b) Electrical connection

Ultrasonic object sensor

- Used for sensing and measurements
- Sense objects in its path or allow it to run parallel to a wall
- Consists T & R
- Ultra sound is pulsed and time taken for the echo to return is measured and distance is calculated
- 8 cycle ultrasonic burse is generated based on an input trigger
- Echo output is made high until it receives an echo
- Based on the duration of echo pulse the object distance is measured

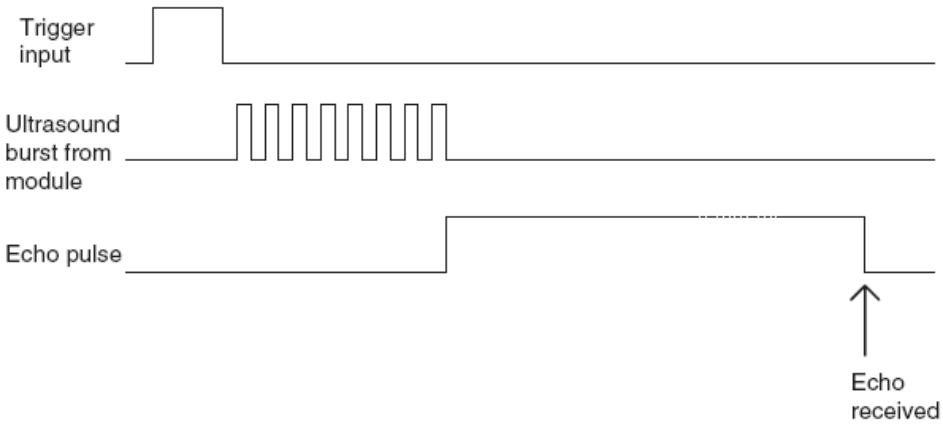


Figure 8.16 Simplified timing diagram for SRF04 ultrasonic ranger

Digital Input

- For microcontroller inputs, logic signals should be at voltage levels equal to logic 0 or 1
- Logic levels are defined by logic family (TTL, CMOS)
- When same families are connected logic levels are reliably transferred
- Logic levels may not be interpreted correctly by receiver when
  - Generated by non-logic source – sensors
  - Traveled over long communication link
  - Have been Subject to interference
- When supply exceed 5V or falls below 0V protection diodes will safe guard the circuit up to some extent

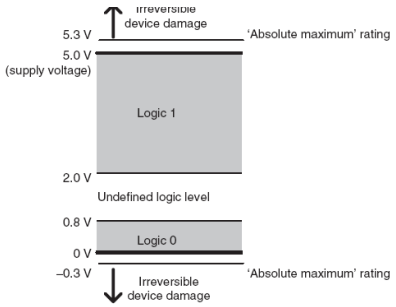


Figure 8.17 Port bit input voltage levels, 5 V supply

a) Possible damage
b) No damage but misleading measurement- particularly when fed to counter, serial clock or serial data
c) Filtering or long cable or sensor output effect
d) Voltage offset - long distance transmission or earth reference voltage difference in T& R

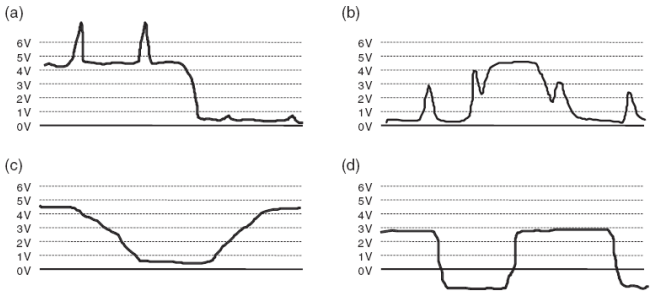


Figure 8.18 Different forms of signal corruption. (a) Spikes in signal, potentially harmful to device input. (b) Spikes in signal. (c) Excessively slow edges. (d) DC offset in signal

Preventing deviated logic signals

- Clamping voltage spikes – with current limiting resistor
- Schmitt trigger
- Analog input filtering
- Opto-isolation
- Digital input filtering

Switch bouncing

- Switches bounce as they close for less than 10 ms – leads to improper input values
- Software prevention mechanisms to overcome switch bouncing
    - Delay to avoid bouncing

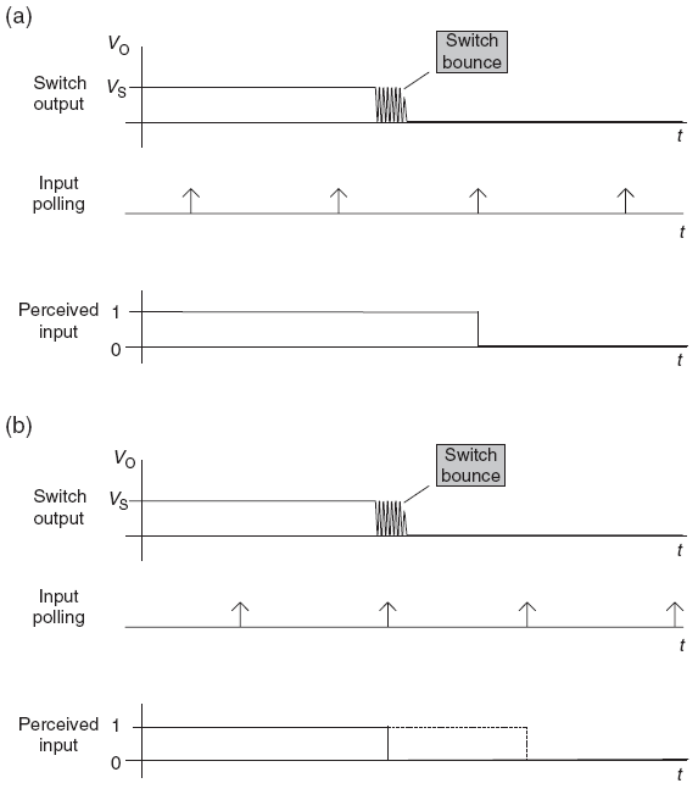


Figure 8.21 Eliminating switch bounce by polling. (a) Input poll misses bounce. (b) Input poll hits bounce

Actuators and motors

- DC and stepper motor
  - compete for same applications

•Both used for continuous rotary or angular displacement

•Stepper motors are suitable if
  - •Precise and limited rotary motion is required and
  - •Power is not important

•DC motor is selected for
  - •Simplicity of driving and good efficiency
  - •But, effect control Feedback is necessary

- Servo motors

•Used in radio-controlled modelling and robotics
•Allows precise angular positioning
•Input is pulse stream generally with 50 Hz repetition rate (period of 20 ms)
•Width determines angular position of the shaft

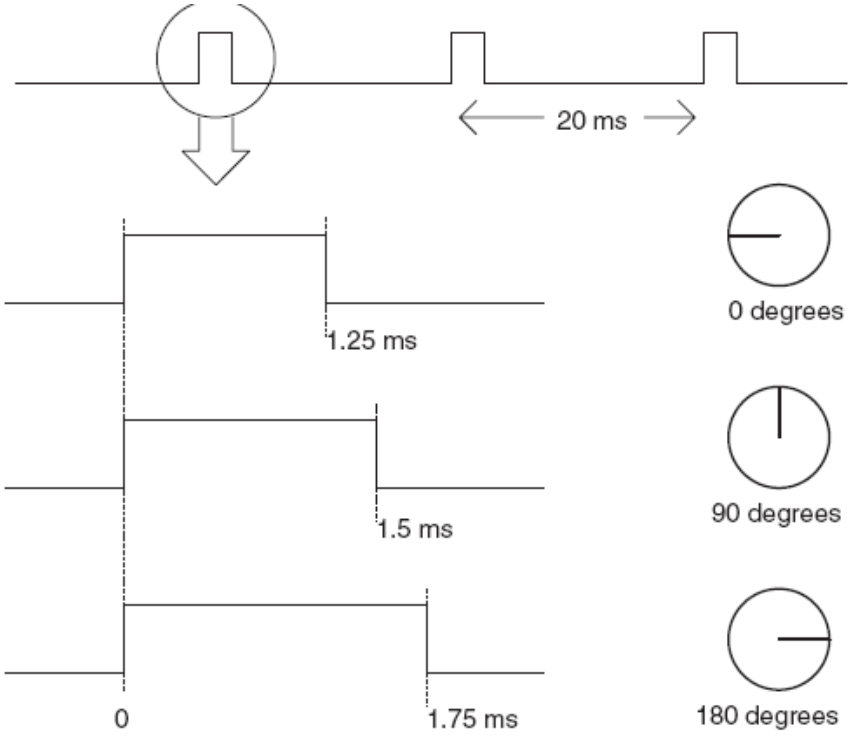


Figure 8.23 Servo input and output characteristics

- An application of pulse width modulation
- Servo motors can be used to rotate sensors in all directions