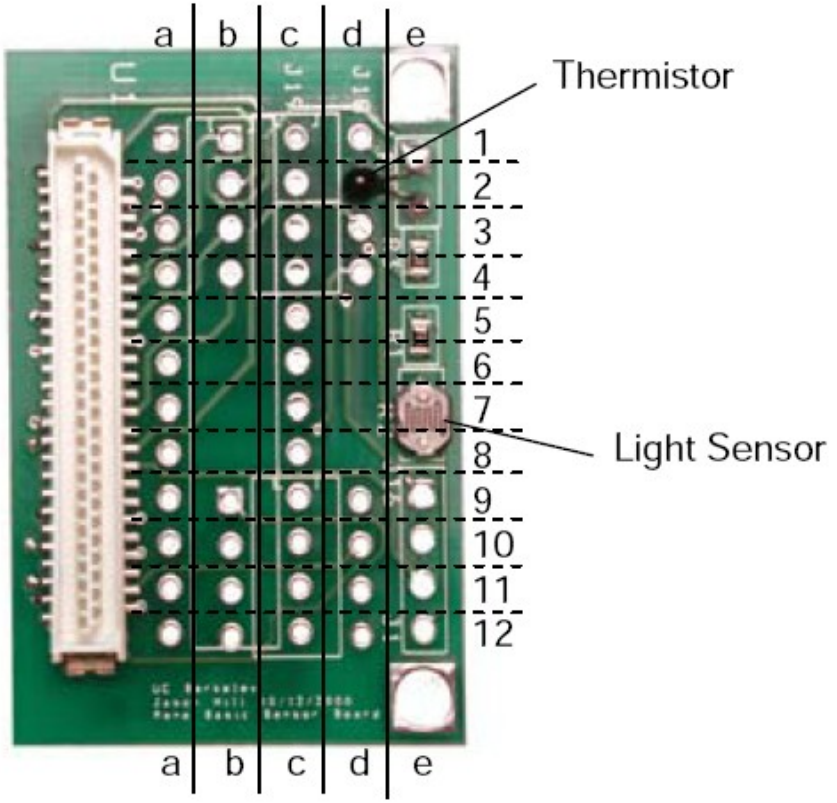
Hardware and Board

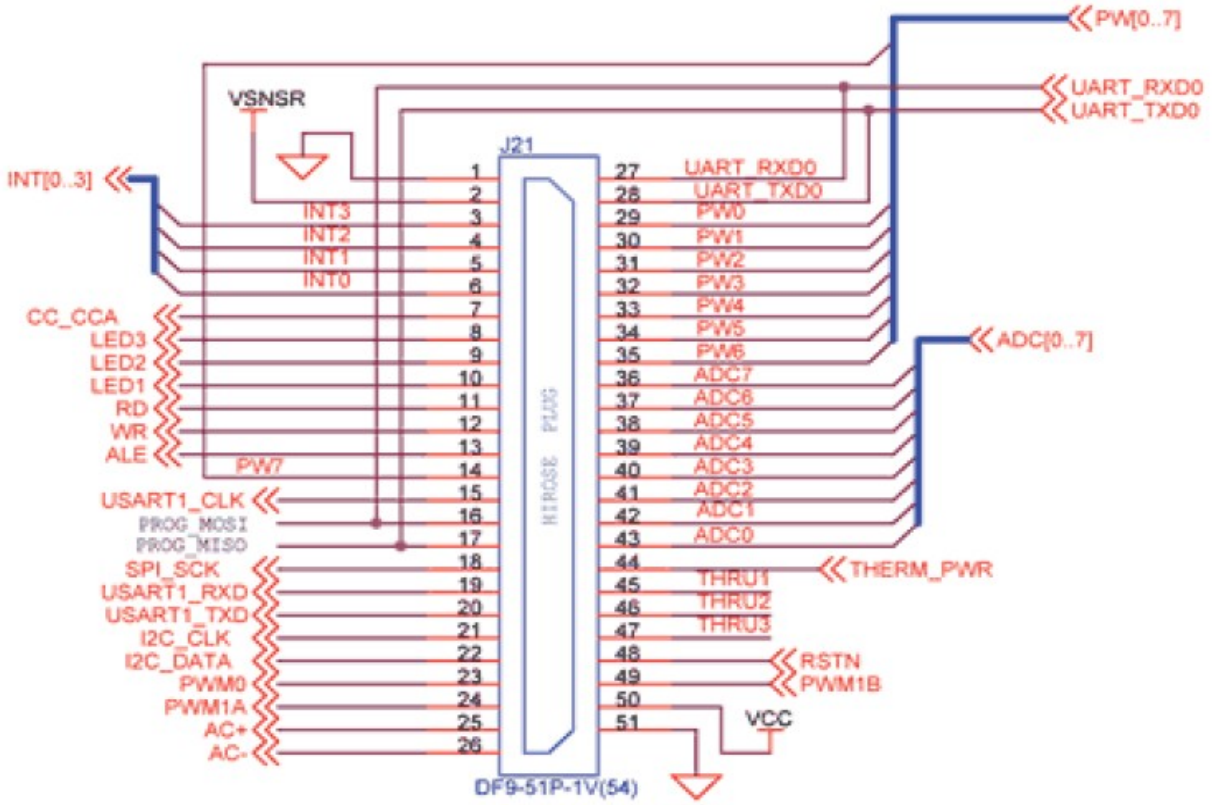
Chapter 3

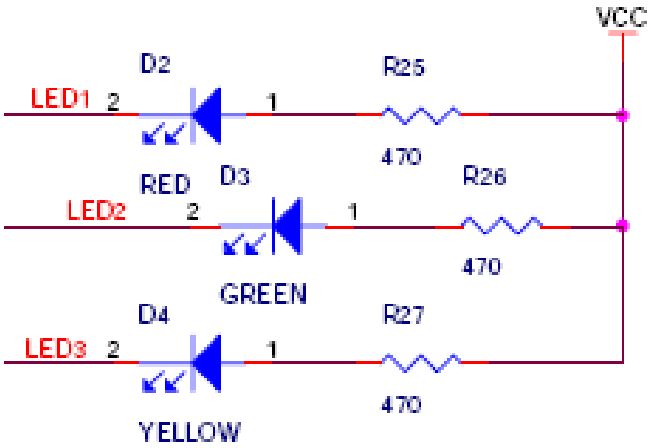
Circuit Board



Schematic of Circuit Board

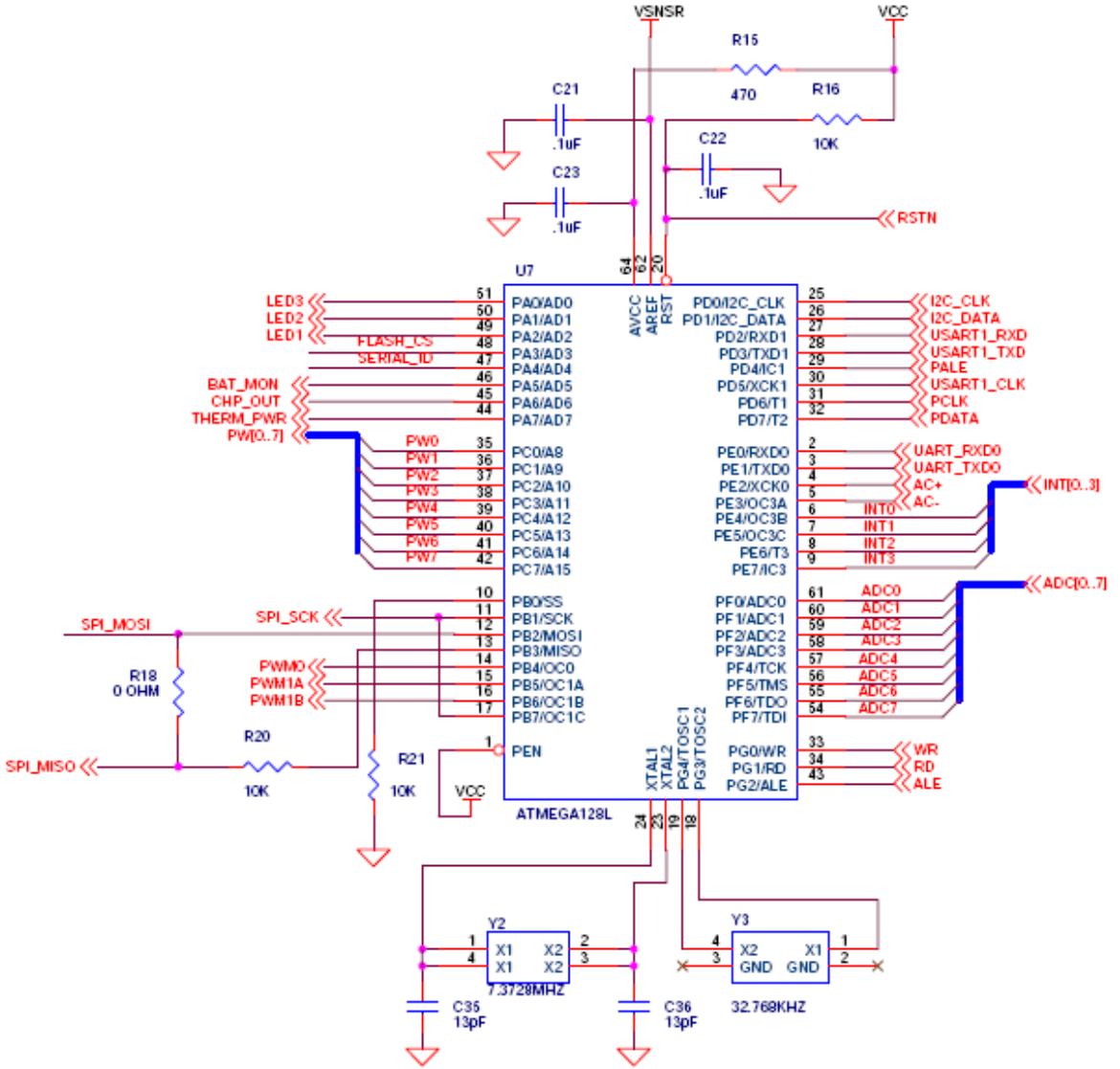
- Connector and LED





Schematic of Circuit Board

- CPU



Schematic of LEDs

- How does CPU control LEDs
  - LEDs' wiring with power
    - With a resister to Vcc
    - 0 on, 1 off
  - LEDs' wiring with CPU's IO pins
    - CPU IO Pins: PA2-PA0
  - LEDs' wiring with extended ports
    - Socket Pins: 10-8
  - The circuit of LEDs?

Circuit Materials

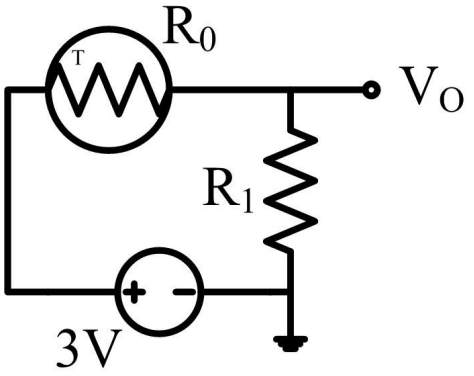
- Conductors
- Insulators
- Semiconductors
- Physical properties of materials
  - What signals can be utilized?
  - How are signals generated and affected by materials?
- Power supply and ground

Circuit Components

- Resistor (ohm): Fig. 3-12b, how to use them?
  - Potentiometer
  - Photo resistor
  - Thermistor
- Factors
  - Tolerance (precision)
  - Power rating
  - Temperature coefficient
- Resistance
  - 10K-10M ohm in ICs (low power consumption)

Sensor

- How does a photo resistor work
  - Make a serial circuit of a photo resistor (R0) and a regular resistor (R1=10KΩ), and then measure the voltage on the regular resistor.
  - Assume the resistance of the photo resistor is R0 = 10-L*c (KΩ)
  - I = V/(R0+R1) = V/(20-L*c)
  - Vo = I*R1 = V*10/(20-L*c)
  - L = (20-V*10/Vo)/c



Circuit Components

- Capacitor (farad): Fig. 3-14b
  - Electric field
  - Bipolar/non-polarized
  - Polarized
  - Variable
- Factors
  - Tolerance (precision)
  - Temperature coefficient
- Capacitance
  - 10pf-100uf in ICs (high frequency)
  - 10mf-1f in big systems (appliance, camera, high energy reservation)

Circuit Components

- Inductor (henry) : Fig. 3-16b
  - Magnetic field
  - Air core
  - Iron core
- Factors
  - Tolerance (precision)
  - Power rating (inertial resistance, heat)
  - Size (hard to be made in ICs)
- Inductance
  - 1nh-10uh

Circuit Components

- Diode : Fig. 3-17b
  - LED
  - Photo diode (reverse connection with power)
  - Zener (reverse connection with power)
- Transistor
  - BJT : Fig. 3-21b, 3-22b
  - JFET : Fig. 3-28
  - MOSFET : Fig. 3-25
  - CMOS

Circuit Components

- Sensors
  - Changes in voltage or current, then detected by a sampling circuit as raw data.
  - Light, temperature, magnetic
  - Microphone (acoustic)
    - Vibration -> change in resistance or capacitance or inductance
  - Accelerometer (motion)
    - Force -> change in capacitance or resistance

Design a Roomba

- Google “roomba video”
- How it bumps off the wall?
- How it moves along a spiral?
- How it prevents falling from a stair?
- How it detects if a part is missing?
- Must the data be accurate?
  - Does the data require precise resister or any circuit components?

Circuit Components

- Oscillator : http://en.wikipedia.org/wiki/Electronic_oscillator
  - Clock, frequency generator (100KHz-100MHz), frequency filter
  - Precision
    - Atomic, 10^{-9} or better
    - Quaz, 10^{-5}-10^{-7}
    - Circuit, 10^{-2}-10^{-4}
- Connector : http://en.wikipedia.org/wiki/Electrical_connector
- Switch : http://en.wikipedia.org/wiki/Switch

Circuit Components

- IC
  - Scale (number of gates)
    - SSI: 100
      - 74xx chips
    - MSI: 100-10K
    - LSI: 10K-100K
    - VLSI: 100K-1M
    - ULSI: >1M
  - Power consumption
  - Speed

Circuit Components

- IC
  - Functionality
    - CPU
    - ADC, DAC
    - RAM, ROM
    - Power
    - Amplifier
    - IO
  - Reliability
  - Debugging

Packages

- Packages : http://en.wikipedia.org/wiki/Category:Chip_carriers
  - Factors: size, heat, frequency
  - SIP, single in-line package
  - DIP, dual in-line package
  - ZIP, zig-zag in-line package
  - QIP, quadruple in-line package
  - QFP, quad flat package
  - PGA, pin grid array
  - BGA, ball grid array
  - LGA, land grid array