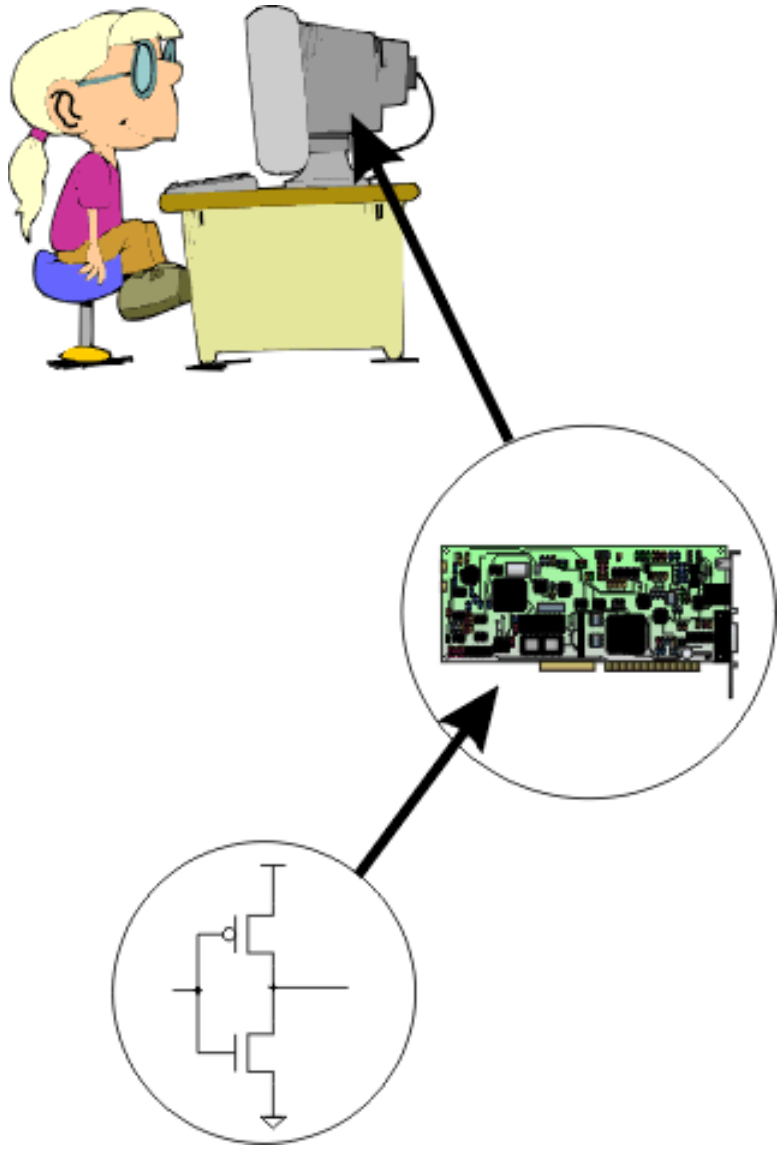
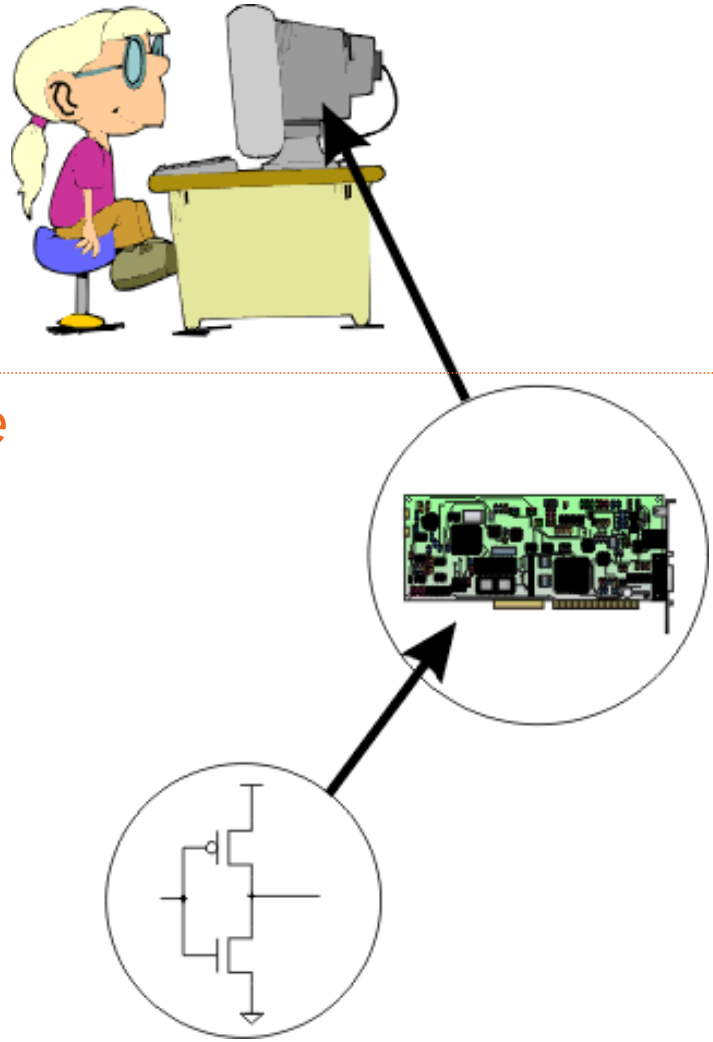
Introduction to Digital Logic



ECGR2181
Lecture Notes 1

Reading: syllabus, Chapter 1

Computer System: Layers of Abstraction



Software

Hardware

Application Program

Language

Operating System

Instruction Set Architecture
(and I/O Interfaces)

Microarchitecture

Logic Gates

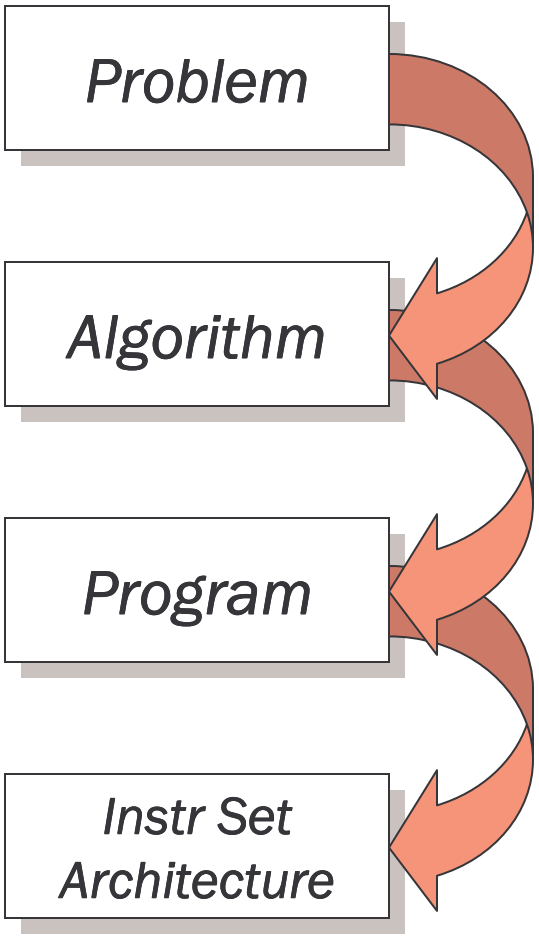
Circuits

Devices

Big Idea #1: Transformations Between Layers

How do we solve a problem using a computer?

A systematic sequence of transformations between layers of abstraction.

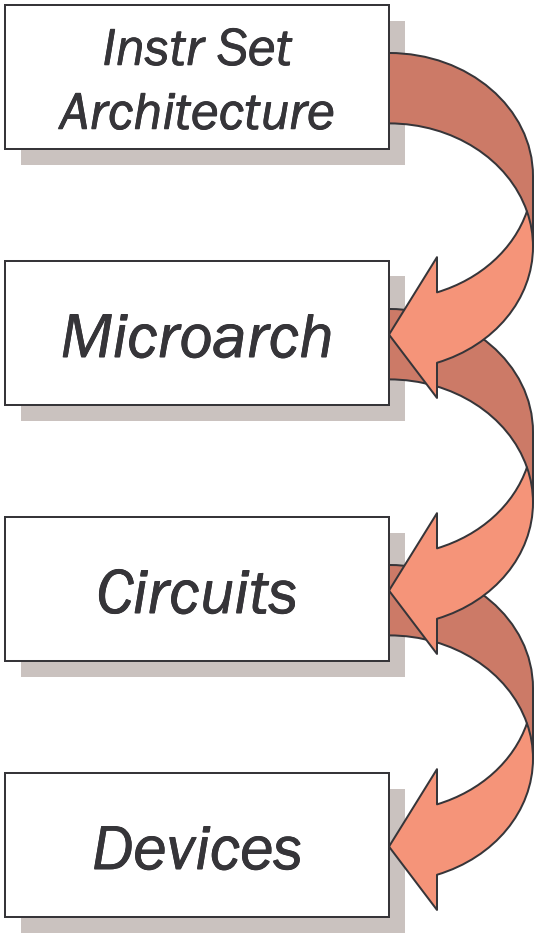


Software Design:
choose algorithms and data structures

Programming:
use language to express design

Compiling/Interpreting:
convert language to machine instructions

Deeper and Deeper…

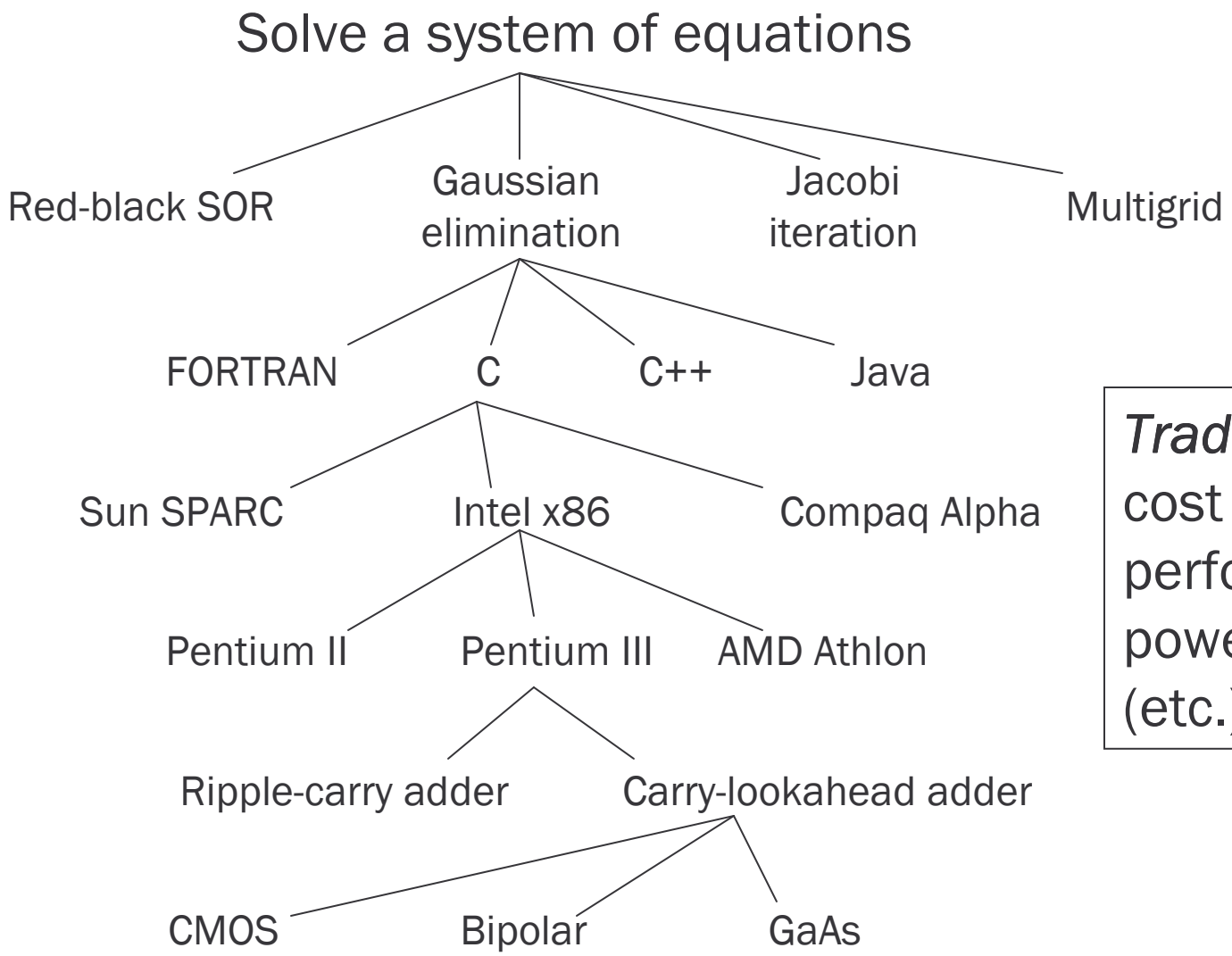


Processor Design:
choose structures to implement ISA

Logic/Circuit Design:
gates and low-level circuits to implement components

Process Engineering & Fabrication:
develop and manufacture lowest-level components

Many Choices at Each Layer



Tradeoffs:
cost
performance
power
(etc.)

How do we represent data in a computer?

At the lowest level, a computer is an electronic machine.

- works by controlling the flow of electrons

Easy to recognize two conditions:

1. presence of a voltage – we'll call this state "1"
2. absence of a voltage – we'll call this state "0"

Could base state on *value* of voltage,
but control and detection circuits more complex.

- compare turning on a light switch to
  measuring or regulating voltage

We'll see examples of these circuits in later chapters.

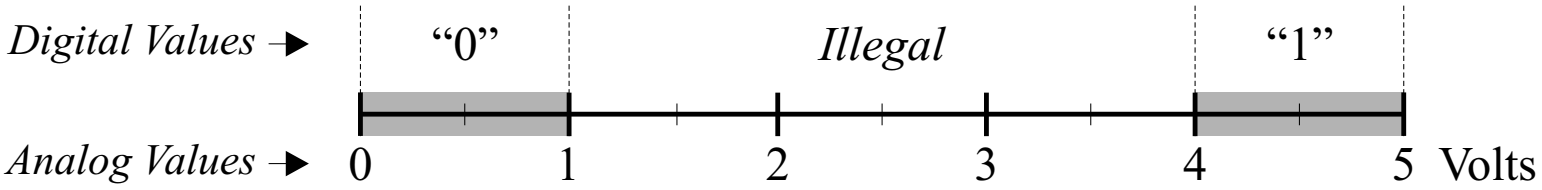
Computer is a binary digital system.

Digital system:

- finite number of symbols

Binary (base two) system:

- has two states: 0 and 1

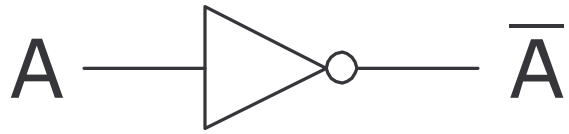


Basic unit of information is the *binary digit*, or ***bit***.

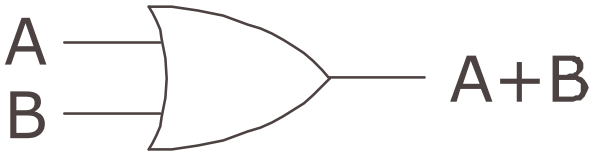
Values with more than two states require multiple bits.

- A collection of two bits has four possible states:
  00, 01, 10, 11
- A collection of three bits has eight possible states:
- *A collection of **n** bits has **2^n** possible states.*

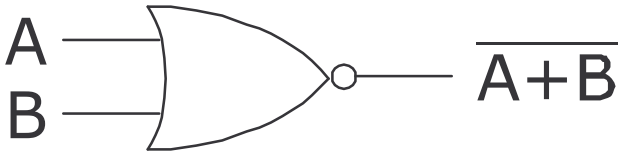
Basic Logic Gates



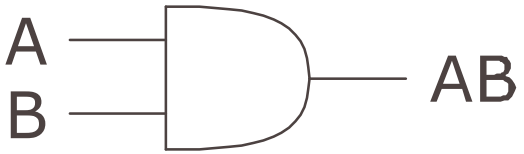
NOT



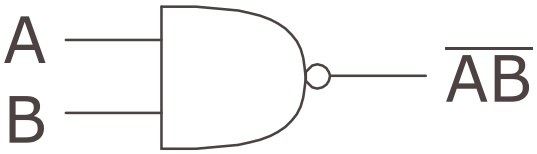
OR



NOR



AND

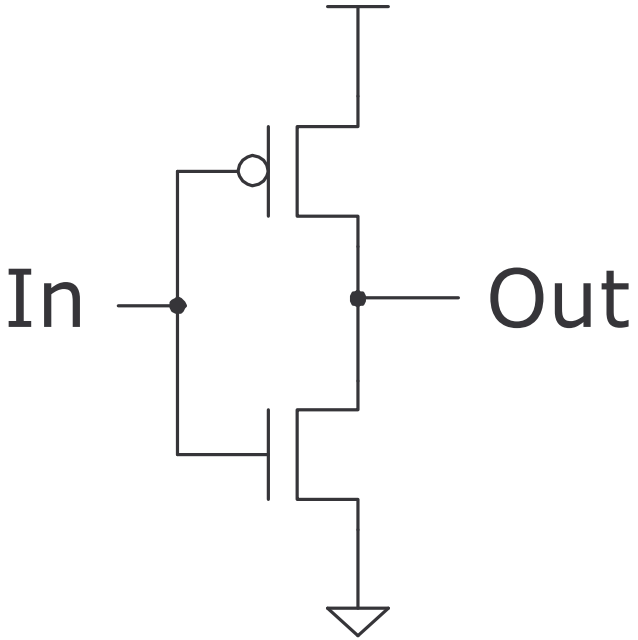


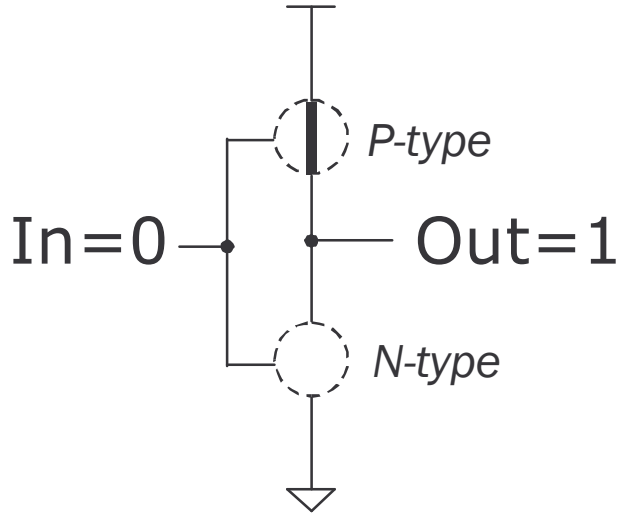
NAND

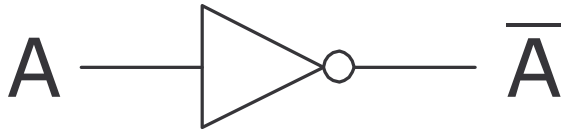
Building a Truth Table

AND **OR** **NOT**

Inverter (NOT Gate)







In	Out
0V	2.9V
2.9V	0V

In	Out
0	1
1	0

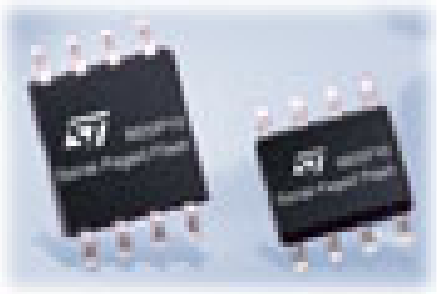
Electronics Packaging

- There are several packaging technologies available that an engineer can use to create electronic devices.
- Some are suitable for inexpensive toys but not miniature consumer products, and some are suitable for miniature consumer products but not inexpensive toys.
- These packages have metal leads that are the conductive wire that connect electricity from the outside world to the silicon inside the package.
- Leads between packages are connected with small copper traces on a printed circuit board (PCB), and the package leads are soldered to the PCB.

Examples of Electronics Packages

Dual In-line Package (DIP) Older technology, requires the metal leads to go through a hole in the printed circuit board.

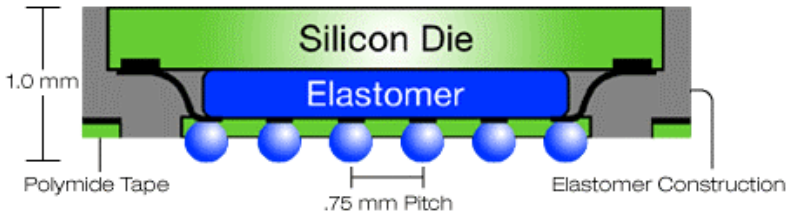
Dual Flat Pack (DFP) - A fairly recent technology, metal leads solder to the surface of the printed circuit board.



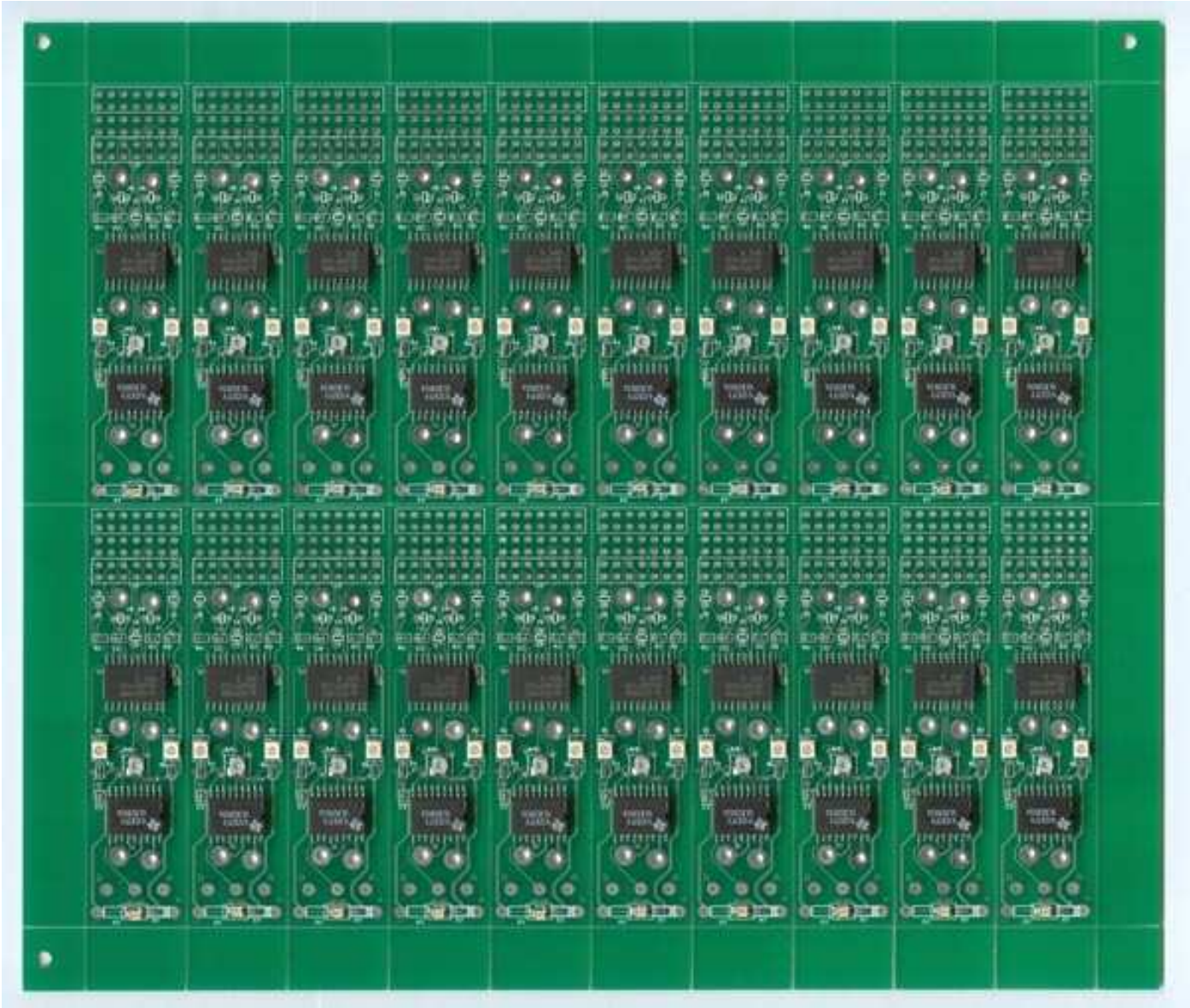
Examples of Electronics Packages

Quad Flat Pack (QFP) - like the Dual Flat Pack, except here are metal leads are on four sides.

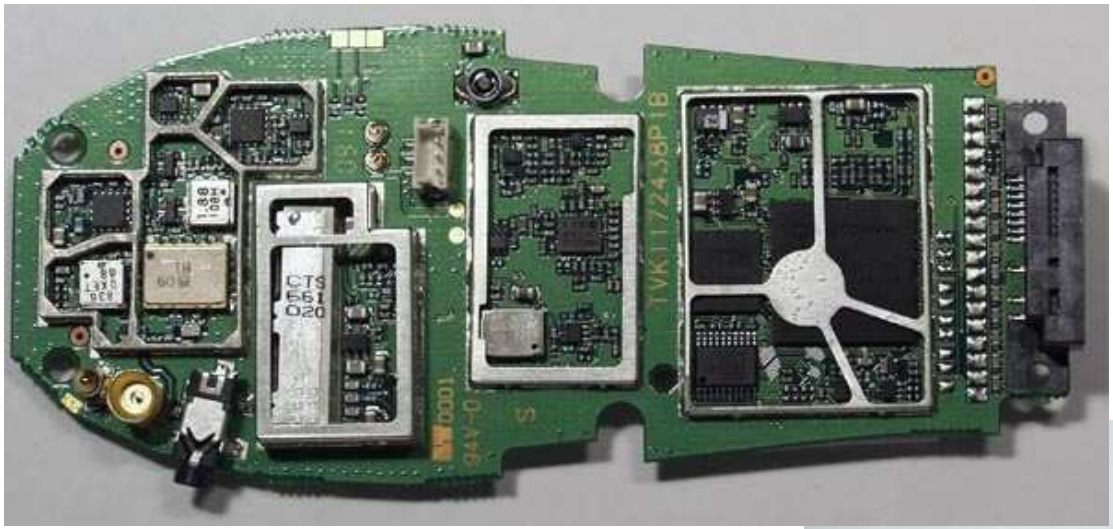
Ball Grid Array (BGA) - The connections to the component are on the bottom of the chip, and have balls of solder on these connections.

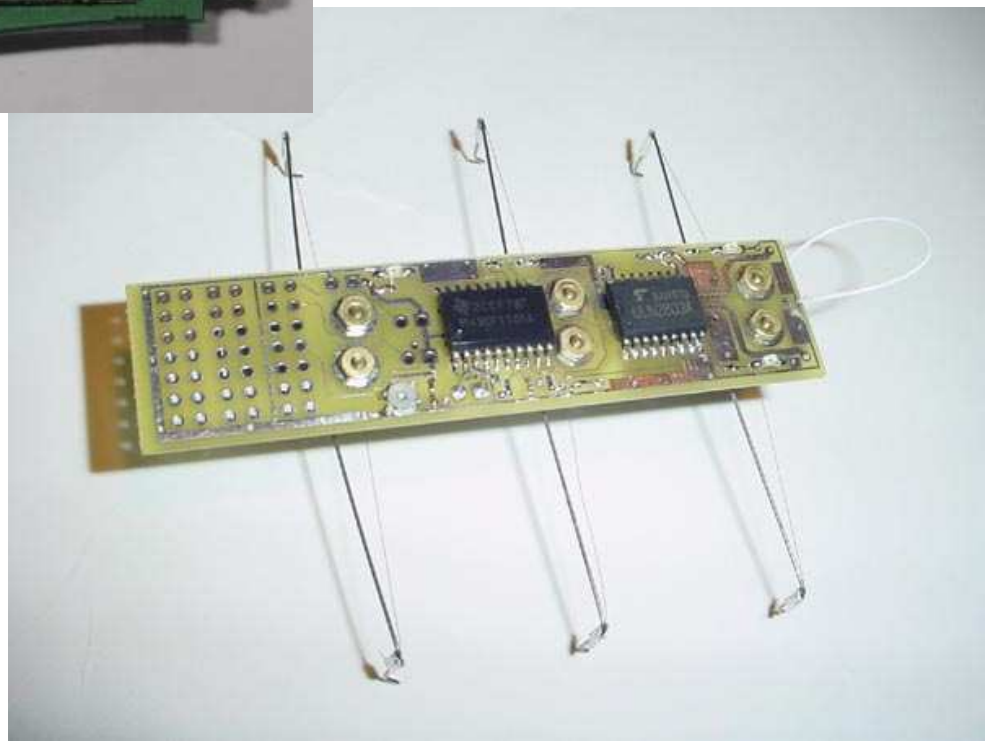


Using these Components



The End Products





Before Next Class . . . .

- Visit the class website
  - Homework 1 will be posted
  - Transparencies will be posted
- Read Chapter 1 and 2