ECE 4101/5101/6090, Fall 2004: Lab 1
An Application of an Embedded System: Inside a Mobile Phone

General Information

Check out a phone and Torx #6 screwdriver to perform this lab during your lab session.

Learning Objectives

This lab will familiarize you with an embedded system. We will look at the packaging and computer organization technology used today. You will open up a mobile phone and identify the parts inside, and learn how they can work together to form a complete computer system.

Prelab Assignment

Visit the web site http://www.howthingswork.com/cell-phone.htm and read about mobile phone technology. Based on what you read, answer the following questions:

1.   What does the acronym GSM stand for?

2.   What does the acronym CDMA stand for?

3.   What are the differences between GSM and CDMA technology (in less than 50 words)?

4.   What technology is IDEN (Nextel's system) more like?

5.   What is the URL of the web page that shows the inside of a mobile phone?

Visit the class web site to see an example of how a printed circuit board is manufactured. Based on what you read, answer the following questions:

6.   What is the first MANUFACTURING step that is likely done for this board production (hint: There is not a picture of it, and it is implied!)

7.   What is done first: hand/manual placement of parts or robotic placement of parts?

8.   Can manufacturing of this board be done completely manually? Why or why not?

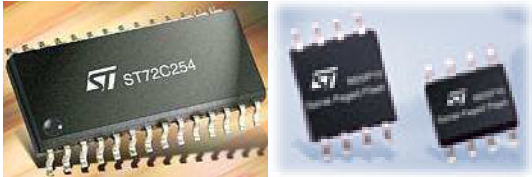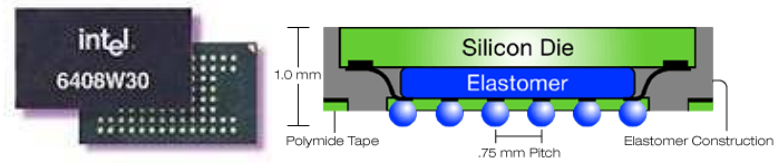Turn the answers to these questions with the rest of the lab.
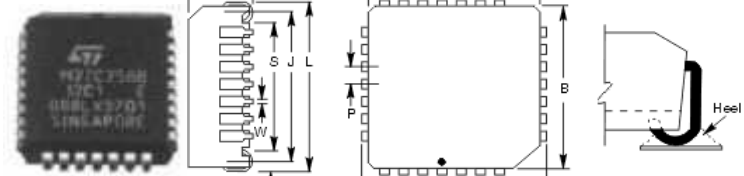
Laboratory Assignments

A mobile phone is nothing more than a computer system that has been shrunk to a very small size. A computer system is characterized by several components:

1.   Input device (i.e. keyboard, mouse, scanner, disk)

2.   Output device (i.e. Monitor, printer, disk)

3.   Processing unit and control unit (typically a single unit called a Central Processing Unit - CPU)

4.   Memory (i.e. Random Access Memory, Read-Only Memory - RAM, ROM)

A mobile phone has all of these parts as well, though the size of them may be smaller than on your typical Pentium IV PC. A mobile phone is an example of an "embedded System." The main characteristic of an embedded system is that the entire computer system carries out one specific function, which is not typically changed. An automobile computer, a PlayStation console, or a network hub box are examples of embedded systems. A PC is not.

One important aspect of mobile phone development is to use electrical components that are small, so that together, all of the components take up a small space. 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 inexpensive toys. An example of these technologies is shown below. 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.

Technology	Picture
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.	
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 to the collections	
J-Lead - The connections on the component are like a QFP part, but the wire LEDs are curled under the part.	

Resistors, inductors, and capacitors are small "block" parts with metal on the ends.

Engineers may design products that use several of these packaging technologies. They will do this to take advantage of lower costs of some packing options, or take advantage of higher densities of other options.

Lab Procedure

Your task will be to open up a mobile phone and identify the major parts of the phone and the printed circuit board. Make sure you follow the instructions carefully.

1. Using a piece of paper and a pencil, write down all of the steps that you used to open the phone. Use the paper at he end of this lab.

2. Using the torx screwdriver, take the phone apart.

3. Examine each piece. Answer the questions at the end of the lab. (major assemblies, Input/Output, BGAs, DIPs QFPs, CPU).

4. Following the written directions from step one, reassemble the phone (follow the instructions in reverse order)

Some helpful hints:

-   BE CAREFUL WITH THE GLASS LCD! It can cut you.

-   Do not disassemble the phone beyond the five major assemblies.

-   There are two different kinds of screws - blue and yellow. Match the colors. Note: The blue ones may look black.

-   Handle the parts carefully - plastic parts can break!

-   If you are not sure something can be taken apart, ask!

Printed Circuit Board (PCB)

Radio Tx/Rx section

Radio control section

Computer section
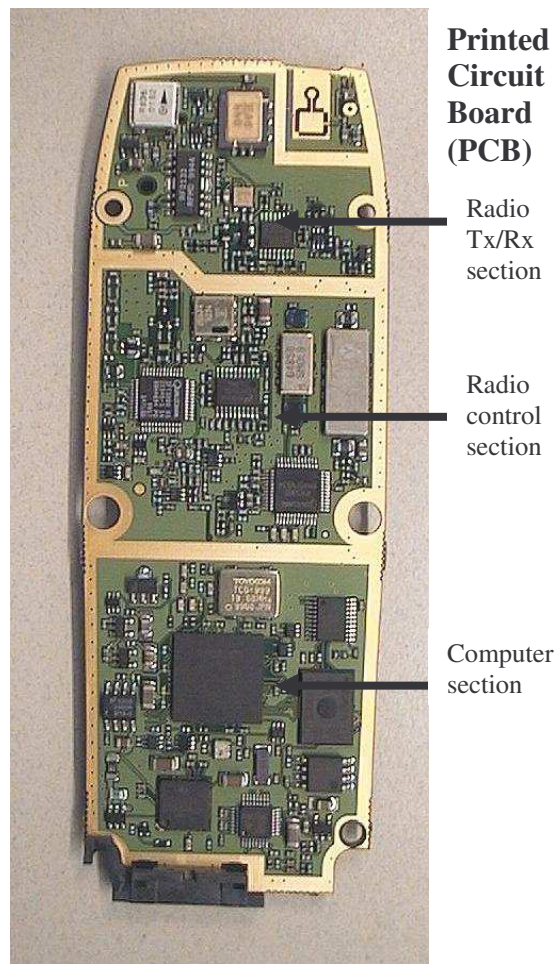
Complete this lab and turn it in to the instructor at the start of class. You can use the following pages.

Names:_____

Prelab Exercises (5 points)

Visit the web site http://www.howthingswork.com/cell-phone.htm and read about mobile phone technology. Based on what you read, answer the following questions:

1. What does the acronym GSM stand for?

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6. What is the first MANUFACTURING step that is likely done for this board production (hint: There is not a picture of it, and it is implied!)

7. What is done first: hand/manual placement of parts or robotic placement of parts?

8. Can manufacturing of this board be done completely manually? Why or why not?

Lab Exercises (15 points)

Write the phone disassembly steps:

What are the five major assemblies of this phone? (don't count small parts like screws).
1. .
2. .
3. .
4. .
5. .

List all of the input devices you see on the phone.

List all of the output devices you see on the phone.

How many BGA parts do you see on the phone? (do not disassemble the major assemblies)

How many DFP parts do you see on the phone with more than eight leads? (do not disassemble the major assemblies)

How many DIP and through hole parts do you see on the phone? (do not disassemble the major assemblies)

Point out what you think is the microprocessor (CPU) on the PCB picture below.
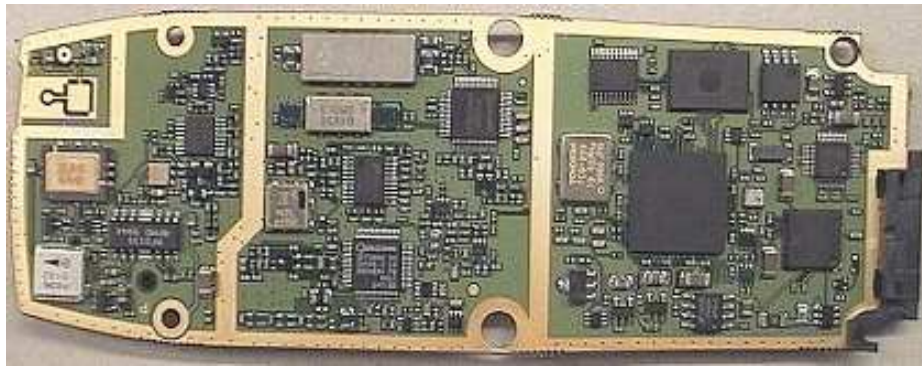
If you were a mobile phone software developer, how do you think you would be able to load and test a new software build?

What other test/debug interfaces do you see on the phone? What tools would you use?

Reassemble the phone, and return it and the Torx screwdriver.