ECE 4101/5101/6090, Fall 2006: Lab 1

An Application of an Embedded System: Inside a Consumer Toy

General Information

Your lab team must have a Furby Toy to perform this lab. You will also need scissors/knife and a Phillips-head screwdriver #1.

Learning Objectives

This lab will familiarize you with an embedded system. We will look at the packaging and computer organization of a high-volume consumer product (toy). You will examine the toy and identify the parts, and learn how they can work together to form a complete embedded system.

Prelab Assignment

None

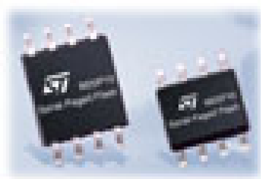
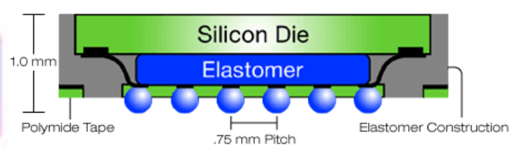
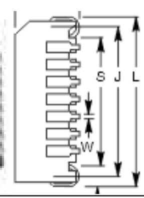
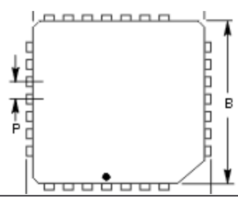
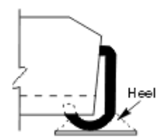
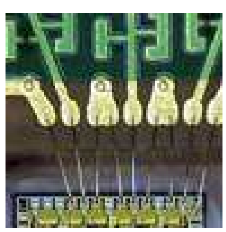
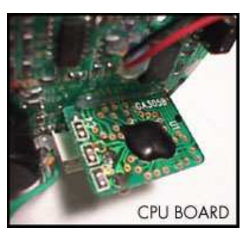
Laboratory Assignments

Embedded systems are 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)

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 product 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 <u>through a hole</u> in the printed circuit board. Other parts, like LEDs, can also have leads that go through the 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.	   
Wire bond and epoxy – a chip is glued to a PCB, wires are soldered to the chip and PCB, then a “blob” of dark epoxy is put over the chip and wires.	 

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

Complete this lab and turn it in to the instructor at the start of class on the due date. Use the template provided on the website.

Lab Questions

There is no doubt about it – companies try to make money. Companies do not stay in business long if they always lose money.

How does a company make money? Simply:
(Income from product sales) – (cost of product) – (cost of sales) – (overhead)
= net income, before taxes .

As a low level engineer, you usually have the most influence over the "cost of product". You may have a small impact on sales (making it "neater"), but you also have a negative impact if your product does not work at all, or is not available in the "sales window."

We will examine a classic technology toy, the Furby. The Furby is truly an embedded system – it has a microcontroller, on-board memory, and I/O. It interfaces with the outside world and runs a pre-determined set of actions. Most amazing is that all this is done for a commercial product that sells for $30. A rule of thumb says that the parts and manufacturing would be about $7.

The objective of this lab is to identify the components of this consumer product. Lab procedure:

1. Visit the web page http://www.phobe.com/furby/ to read about opening up a Furby.
2. Use the instruction on http://www.phobe.com/furby/auto1.html to take the covers off a Furby.
3. Read http://www.phobe.com/furby/guts.html and use it as a guide to identify all of the I/O.
4. Visit http://www.phobe.com/furby/hacking to read more about the Furby electronics.
5. Answer the following questions.

Questions:

1. List all of the input sensors that are affected by a user of a Furby (ones which you have control over during normal operation). Identify if these are analog or digital inputs.
2. List all of the input sensors that "internal" to a Furby (ones that are used by the microprocessor to control Furby during normal operation). Identify if these are analog or digital inputs.
3. List the devices that are controlled by the microcontroller. Identify what packaging technology they are.
4. List the other devices that are not related to I/O sensors/actuators, but are powered.
5. Make a list of the remaining parts in this product (it does not have to be exhaustive, for example, you can say "gears" to include all gears, or "fur" to include the entire outside).
6. Approximate the cost of each of the materials listed in questions 1 through 5. Include about $0.50 for assembly/factory tools. Add them up for an estimated cost.

During TA office hours, show your Furby to the TA, and be prepared to identify the microcontroller, one output/controlled device, and three input devices.

Turn in your lab report when you show your Furby to the TA.