1 Objective

Design a simple embedded system capable of running on a wide range of power supply voltages. Justification of design decisions.

2 Pre-lab Tasks

Do the following tasks before you come to lab period:

1. Review methods of switch debouncing in hardware and software

2. Determine schematics and software flowcharts for debouncing switches. List advantages and disadvantages of each. (Include this discussion in your lab submission.)

3. Choose a method of switch debouncing and justify your choice.

3 Specification

Using the parts in the ECE 3724 parts kit or other ECE 4723/6723 approved parts, design a system that will periodically turn on an LED for 0.5 s and off for 2.0 s (20% duty cycle).

Your system has two pushbuttons (PBs) to control the LED flash sequence. PB1 will control the LED duty cycle. PB2 will enable/disable the LED flashing. Pressing PB1 will change the LED duty cycle to 80% (on for 2.0 s and off for 0.5 s). The human-machine interface should respond perfectly. A single press of the PBs will correspond to a single (and seemingly instant) change of the system’s behavior. The system’s behavior on power-up must be LED flashing with a 20% duty cycle. The LED flashing is disabled by holding down PB2. Releasing PB2 will return the system to its previous state, LED flashing at the last duty cycle.

Your system must operate properly (using the same firmware) at $V_{dd} = 2.0 \text{V}$, $V_{dd} = 2.5 \text{V}$, $V_{dd} = 3.3 \text{V}$, and $V_{dd} = 5.0 \text{V}$. Your system should not require any change of components to alter the system’s voltage, but may require switch state changes.

4 Demonstrations

You must do the following for each system operating voltage:

1. Use the oscilloscope to measure the period and duty cycle of the flashing LED under both duty cycles. Include oscilloscope screenshots to document your measurements.

2. Measure the supply current draw $I_{dd}$. The current $I_{dd}$ you measure should be the current provided to the functional parts of your design, i.e. CPU, LEDs, etc. The measured current should not be for parts that are not germane to the task specified here. Measure the supply current $I_{dd}$ for each unique period of operation for each supply voltage. Provide your results in a table and plot the current versus the supply voltage.

3. Measure the ground current sink $I_{ss}$. The current $I_{ss}$ you measure should be the current coming from the functional parts of your design, i.e. CPU, LEDs, etc. Measure the ground current $I_{ss}$ for each unique period of operation for each supply voltage. Provide your results in a table and plot the current versus the supply voltage.

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1 Perform before you leave lab.
5 Deliverables

1. Document showing your design analysis justifying component values and circuit topology. ("I put it together and it just worked" is not acceptable. You must justify your design decisions.) If you are unable to meet any of the design specifications, you must provide justification as to why it is not possible.

2. Schematic capture of your circuit showing all components and their values (include everything except the breadboard). Submit BOTH the “raw” electronic schematic file AND a PDF document suitable for printing. You may use any schematic capture tool you desire, but you are encouraged to use a tool which will allow ultimate import into PCB layout. Your are encouraged to use Cadence/OrCAD or EagleCAD.

3. Table of values recorded during in-lab demonstrations. Your table must include data for LED periods and current measurements at each operating voltage.

4. Screenshot or other documentation as supporting evident of the values in the part above.

5. Code tree of your developed firmware (with all code adhering to the ECE 4723/6723 coding conventions).

6 Bonus

Each member of the team with the lowest average $I_{dd}$ current at $V_{dd} = 3.3V$ will receive an additional 10 points on this lab task. All team members must demonstrate full functionality for their team to be considered.

Your team can share ideas and have discussions about how to tackle the lab problem stated here. You can tell each other exactly how you designed your system. In fact, it is advantageous for you to share your “great” ideas with your teammates. What you cannot do is use the same hardware or give a copy of your code to your teammates (this includes dictating code to them as they type).

7 History

v1.0 5 SEPT 2006 – Initial version

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2Submit electronically to lab TA.