Lab Task #7

1 Objective
Design a “low-power” embedded system and investigate the transition periods in low-power systems.

2 Pre-lab Tasks
Do the following tasks before you come to lab period:

1. Review MSP430 interrupts and low power modes in the datasheet
2. Write the code to perform the task specification in this assignment.

3 Specification
Using the parts in the ECE 3724 parts kit or other ECE 4723/6723 approved parts, design a MSP430-based system that will periodically turn on a flashing LED. Design a system that will sit in a low power state until a pushbutton is pressed. Upon button press, the system will transition to an active state and flash an LED for eight seconds. The flashing LED should have a 0.5 s period with 50% duty cycle.

Determine a method by which you can, with minimal impact on the system’s timing, determine the state of the system. You must distinguish between four system states:

1. low-power mode
2. transition period between low-power and active modes
3. active mode with LED off,
4. active mode with LED on

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

⚠️ WARNING: Do **NOT** attempt to connect your TI MSP430 to 5.0 V, either to \( V_{dd} \) or any I/O pins. It will not survive the experience.

4 Demonstrations
You must do the following for each system operating voltage:

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

\(^1\)Perform before you leave lab.
2. Accurately measure the period of time between the PB press (request to transition to active mode) and when the processor is actually processing instructions (active mode). Include oscilloscope screenshots to document your measurements.

3. 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 all four system activity states for each supply voltage. Provide your results in a table and plot the current versus the supply voltage.

4. 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 all four system activity states for each supply voltage. Provide your results in a table and plot the current versus the supply voltage.

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. You are encouraged to use Cadence/OrCAD or EagleCAD.

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

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

5. Compare the results of this lab with Lab #3 using the Microchip PIC18Fxx2. Account for any differences.

6. 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 6 SEPT 2006 – Initial version

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1Submit electronically to lab TA.