Microprocessors B (17.384)

Spring 2011

Lecture Outline

Class # 11

April 12, 2011

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Today's Lecture

- Administrative
- Microcontroller Hardware and/or Interface
 - Advanced Hardware Topics
- Programming/Software
 - Programming Techniques
- Lab
- Homework

Course Admin

Administrative

- Admin for tonight ...
 - Syllabus Highlights
 - Exam #2 is next week ... April 19th
 - Lab #4 is due ... April 26th
 - Lab time ...
 - Continue/start Lab #4
 - Course Project
 - Course Project ...
 - If you finished your Labs ... start working your project

Syllabus Review

Week	Date	Topics	Lab	Lab Report Due
1	01/25/11	PIC pin out, C programming, Watchdog Timer, Sleep		
2	02/01/11	General-purpose IO, LED/switch IO, FSM	1	
-3	02/08/11	Lab	1 con't	
4	02/15/11	Interrupts, Timers, interrupt-driven 10	2	
-5	02/22/11	Lab	2 con't	1
6	03/01/11	Asynchronous and Synchronous Serial 10 (UART, I ² C, SPI)	3	
7	03/08/11	Examination 1		
X	03/15/11	No Class – Spring Break		
-8	03/22/11	Lab	3 con't	2
9	03/29/11	Pulse Width Modulation and DC motor control	3, 4	
10	04/05/11	Lab	4 con t	3
7 11	04/12/11	Advanced Hardware Topics	Project	
12	04/19/11	Examination 2		
13	04/26/11	Work on Course Project	Project	4
14	05/03/11	Final Exam/Course Project Brief and Demonstration	Demo	
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Microcontroller Hardware and/or Interfaces

Other Features / Peripherals

Direct memory Access

Direct memory Access (DMA)

- Direct Memory Access ... DMA ...
 - A feature that allows certain hardware subsystems to access system memory for reading and/or writing independently of the CPU
 - Hardware assisted data transfers between memory and peripherals
 - Minimal CPU intervention
 - Reduces CPU overhead

Direct memory Access (DMA)

- Without DMA ... using programmed input/output (PIO) mode for communication with peripheral devices ...
 - The CPU is typically fully occupied for the entire duration of the read or write operation, and is thus unavailable to perform other work
 - With DMA ... the CPU would initiate the transfer ... do other operations while the transfer is in progress ... and ...
 - Receive an interrupt from the DMA controller once the operation has been done

I²C ...

PIC24 as an I²C Slave

- The PIC24 can also function as an I²C Slave
 - Useful when embedding within a product that requires an I²C interface

Bus Arbitration for the I²C Bus

- The I²C bus supports multiple bus masters
 - Any I²C device can initiate a transaction
 - Therefore there must be a bus arbitration mechanism that decides which device assumes control

Controller Area Network

Controller Area Network (CAN)

- Controller Area Network ... CAN ...
 - Is an half-duplex serial bus designed as a communication mechanism for intelligent peripherals within an automotive system
 - An automobile is a harsh environment
 - Electrical noise
 - Electrical systems throughout the vehicle
 - Communications in meters

Controller Area Network (CAN)

- CAN buses ...
 - Uses only two wires for communications
 - Keeps cabling sizes to a minimum

Universal Serial Bus ...

Universal Serial Bus (USB)

- The Universal Serial Bus ... USB ...
 - High speed serial protocol
 - Largely replaced the RS-232
 - Some PIC24 microcontrollers has USB interface
 - PIC24FJ256GB110 ... for example

Real-Time Clocks

Real-Time Clocks

- External
- Internal

Analog Interface ...

Analog Interface

- Analog to Digital Conversions
- Interfacing with and External ADC
- Comparator Module ...
 - Contains two independent comparators
- Temperature Sensors
- Light Sensors
- Accelerometer
- Pressure Sensors

Other Interfaces

Other Interfaces

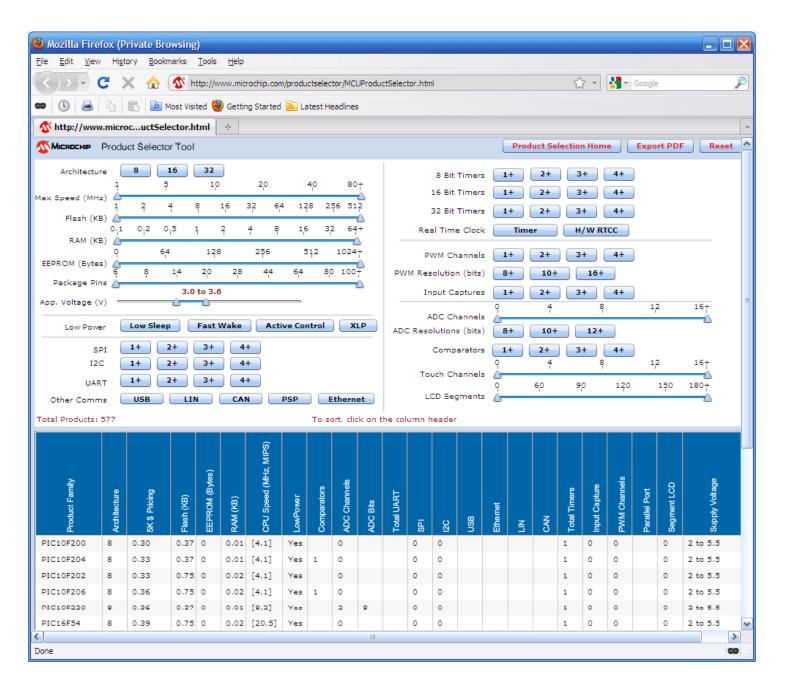
- Liquid Crystal Displays
- Motors
- Stepper Motors
- Data Loggers
- PC interface

Selecting Your Microcontroller ...

Product Selector Tool

- Microchip's Home Page ...
 - Product Selector Tool ...
 - Web address

http://www.microchip.com/productselector/MCUProductSelector.html



Programming/Software

Software enhancements

Assembly Language ...

Assembly Language

- PIC24 instruction set defines 71 distinct instructions
- Assembly language is more primitive ... operations less powerful ... than C
- It can ... however ... be used when C cannot perform the required task
- Can also embed assembly within C

C ...

C

- Pointers and subroutines
- Indirect addressing
- Subroutines

Math Routines ...

Math Routines

- Multiplication
- Division
- Floating Point Numbers
- Solving equations

Optimization Techniques

Optimization Techniques

- Increase Code Efficiency
- Decreasing Code Size
- Reducing Memory Usage
- Power-Saving Techniques

- Inline functions
- Table lookups
- Hand-coded assembly
 - Some software modules are best written in assembly language
 - This gives the programmer an opportunity to make them as efficient as possible
 - Though most C compilers produce much better machine code than the average programmer ...
 - A skilled and experienced assembly programmer might do better work than the compiler for a given function

- Register variables
 - The keyword register can be used when declaring local variables ...
 - This asks the compiler to place the variable into a general-purpose register rather than on the stack
- Global variables
 - It is sometimes more efficient to use a global variable than to pass a parameter to a function

- Fixed-point arithmetic
 - Unless your target platform features a floating-point processor ...
 - You'll pay a very large penalty for manipulating float data in your program

Variable size

- It is typically best to use the processor's native register width for variables whenever possible ... whether it is 8, 16, or 32 bits
- This allows the compiler to produce code that takes advantage of the fast registers built into the processor's machine opcodes
 - For example ... if you need a count that goes from 0 to 512 ... you can't use an 8-bit variable

Decreasing Code Size ...

Decreasing Code Size

- Avoid standard library routines
 - Avoid using large standard library routines
 - They try to handle all possible cases
 - It might be possible to implement a subset of the functionality yourself with significantly less code

Decreasing Code Size

- Use goto statements
 - Good software engineering practice dictates against the use of this technique ... But ...
 - In a pinch ...goto statements ...
 - Can be used to remove complicated control structures

Power-Saving Techniques

Power-Saving Techniques

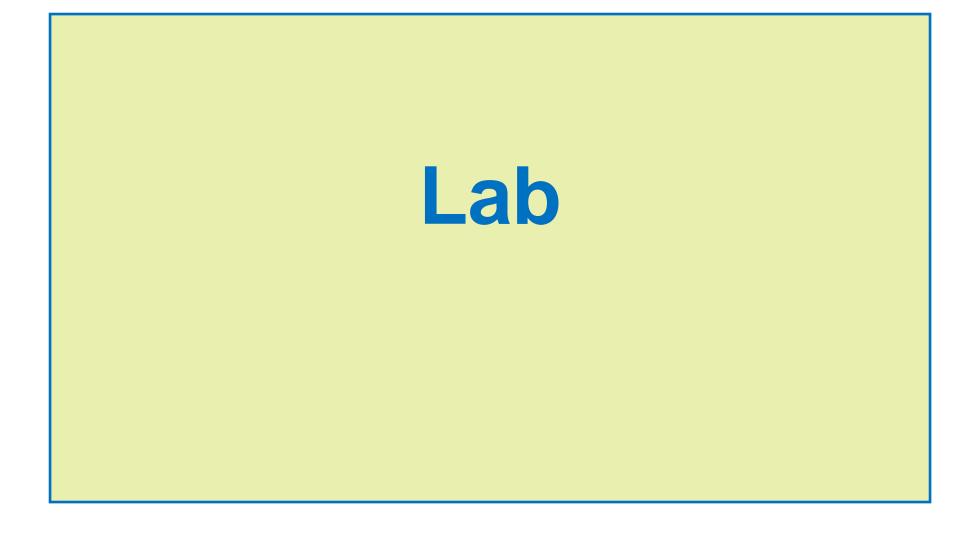
- A major concern in battery-powered embedded systems design is power consumption
- There are several methods to conserve power in an embedded system ... including ...
 - Clock control
 - Power-sensitive processors
 - Low-voltage ICs
- Some power-saving techniques are under software control.

Power-Saving Techniques

- It might seem ideal to select the fastest and most powerful processor available for a particular embedded system ...
 - However ... one of the tasks of the hardware designer is to use ...
 - Just enough processing power to enable the device to get its job done
 - This helps reduce the power consumed by the device

Power-Saving Techniques

- Processor Modes
- Clock Frequency
 - Reduce the clock speed to save power during the execution of noncritical tasks ... and ...
 - Increase the clock speed when processing demands are high



Peer Review of Software ...

Peer Review of Software Developed

- How did you write your code?
- What problems did you encountered?
- Any questions that you need resolved?

Next Class

Next Class Topics

- April 19th ... Exam #2
- Lab time ... projects
 - REMINDER ... I expect to see you working in the lab

Homework

Homework

- Labs ...
 - Lab #4
 - Lab #4 Report ... due April 26th
 - Projects
- Study for exam #2 ... next week ... April 19th

Time to start the lab ...

Lab

- Start / Continue Lab #4
- Start / Continue projects

White Board ...

References

References

1. None