



Microcontroller Selection

(Using the PIC16F87XA and Atmega32 as examples, some info on the XInC2)



Presentation Objective

- To give you an idea of what to look for when evaluating suitability of a microcontroller for a design.
- ...what peripherals a microcontroller has is only part of the picture!
- ...and to let you know which microcontrollers are often used in the lab.

Presentation Outline



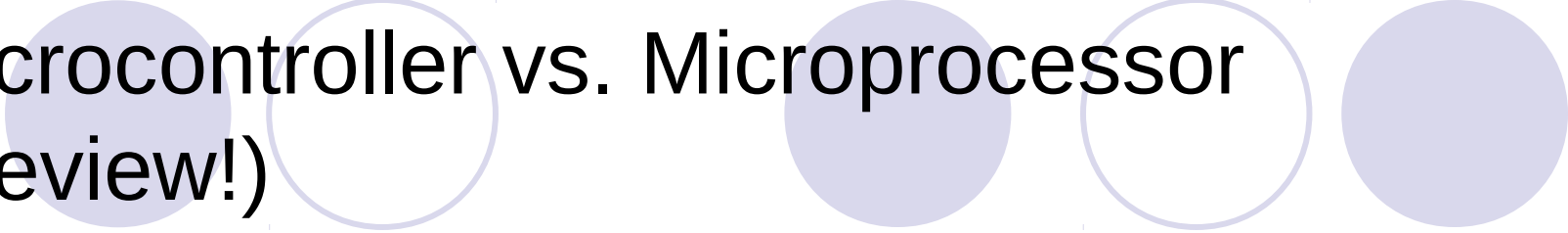
- Sources of Information
- Microcontroller vs. Microprocessor
- Operating Specifications
- MCU Block Diagrams
- CPU
- Memory
 - Program Memory (Flash)
 - Data Memory (RAM)
 - Non-volatile Memory (EEPROM)
- Selecting a Microcontroller



Sources of Information

- The content of this presentation has been developed using the devices' data sheets.

Microcontroller vs. Microprocessor (Review!)



Microcontroller (MCU): an integrated circuit which contains a CPU and a set of peripherals.

Microprocessor (MPU): an integrated circuit that contains a CPU – and that is pretty much it.

Operating Specifications

PIC16F87XA

- DC to 20 MHz
- External Timing Elements
- 5V operation (LF versions down to 2.0V)
- Commercial and Industrial Temperature Ranges available
- Static CMOS Technology

ATMEGA32

- DC to 16 MHz
- Internal Timing Available
- 4.5 to 5.5V operation (L versions down to 2.7V)
- Commercial and Industrial Temperature Ranges available
- Static CMOS Technology

XInC2

- DC to 100 MHz
- External Timing Elements
- 1.8 to 3.6V operation
- Industrial Temperature Range
- Static CMOS Technology



Operating Specifications (cont'd)

Which microcontroller is better?

Operating Specifications (cont'd)

- From the operating specifications, you can see that different microcontrollers have differing characteristics
 - speeds
 - timing elements
 - voltages
 - temperature ranges
 - technology
- We will see, too, that CPUs and memory also differ!

MCU Block Diagrams



- A good place to start characterizing the capabilities of a microcontroller is through its internal block diagram.
- This is a visual depiction of how the device is structured and how pins are attached to particular peripherals.
- Depending on the level of the diagram, some information about the CPU can also be determined.

MCU Block Diagrams (cont'd)



See
Handouts!



The CPU

- Capabilities of a CPU are typically characterized by the *Architecture*, *Instruction Set* and the *Programmer's Model*
- Architecture:
 - Harvard or von Neumann?
 - Address/Data bus width?
 - Opcode size?
- Instruction Set: RISC or CISC?
- Programmer's Model: how many registers?
What addressing modes are available?

The CPU (cont'd)

PIC16F87XA

- Harvard Structure
- 8-bit
- RISC (35 instructions)
- One accumulator (W)
- One indirect pointer register (memory mapped)
- One (non-branching) instruction executes in 4 crystal cycles

Atmega32

- Harvard Structure
- 8-bit
- RISC (131 instructions)
- 32 accumulators
- Three indirect pointer registers (these take up 6 of the accumulators)
- One (non-branching) instruction executes in 1 crystal cycle (usually)

XInC2

- Hybrid Structure
- 16-bit
- RISC (18 instructions)
- 8 general-purpose registers.
- *8 Processor Threads!*
- Mostly single-cycle instructions

The CPU (cont'd)



Which of these microcontrollers is better now?

- The answer really depends on what your design is supposed to do.
- The information provided so far is an abstraction. For instance, most Atmel AVR instructions use NOTHING BUT the 32 accumulators, whereas the PIC instructions can access ANY RAM.
- Only experience, calculations, research, and experimentation will help you determine if a particular MCU will be able to do what you need it to do.

Memory



- Memory could be considered a peripheral!
- The PIC16F87XA and Atmega32 have a Harvard memory structure wherein program memory and data memory are in different memory maps.
- The XInC2 can treat programs as data.
- Both the Atmega32 and the PIC16F87XA also have EEPROM (often used for configuration data) in yet another memory map.

Memory: Program Memory (Flash)

PIC16F87XA

- 100,000 Write Cycles
- 8K x 14
- Each instruction is 14 bits wide.
- Uses a paging scheme.
- Can be read/programmed by firmware.

Atmega32

- 10,000 Write Cycles
- 32K
- Each instruction is 16 or 32 bits wide.
- Can be read/programmed by firmware.

XInC2: None (External memory is required, or MASK ROM production)

Memory: Data Memory (RAM)

PIC16F87XA

- 368 bytes including registers
- Uses a bank selection scheme (4 banks)

Atmega32

- 2K bytes + 96 for registers
- Some addressing modes can access only a portion of the memory.

XInC2: 16K words + 8 16-bit general-purpose registers

Memory: Non-volatile Memory (EEPROM)

PIC16F87XA

- 256 bytes
- 1,000,000 Write Cycles

Atmega32

- 1024 bytes
- 100,000 Write Cycles

XInC2: None (Implemented externally)



Selecting a Microcontroller

- Selecting the best microcontroller for a job is not a simple task!
 - Speed vs. Peripherals vs. Cost vs. Experience vs.
- To confuse matters, different manufacturers offer very similar products:
 - ... vs. Preference vs. Development Tools vs. Documentation Quality vs. Available Packages
- Comprehensive knowledge of potential products is required!
- Experimentation is also often required!

Selecting a Microcontroller

- Some tools exist to help selecting a microcontroller simpler:
 - Vendors such as Digikey (www.digikey.ca), Newark (www.newark.ca), etc. have parametric searches that can narrow the field – be aware, though, that no vendor carries all MCUs!
 - some publications, such as EDN, have summaries that can help: see the Resources|Links menu selection on the course web page (EDN apparently no longer updates this resource in the fashion they used to)
 - don't forget the datasheets and block diagrams!