Microprocessor Architecture

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ECT 313

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What Makes up a Computer?

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What Makes up a Computer?

- CPU
- Memory
- Video
- Keyboard
- Mouse
- Hard drive
- Etc……

Input / Output Devices (I/O)

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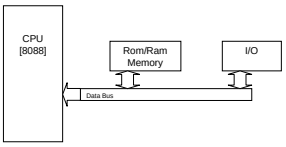
A Computer's Mother Board



- The CPU initiates and controls all communication between devices

- The **data bus** is a set of wires that carry information between the cpu to/from memory and I/O.
  - The data bus is BI-DIRECTIONAL (information can go in either direction)

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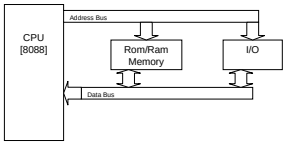
A Computer's Mother Board



- The **address bus** is a set of wires that tells the memory and I/O devices what the CPU wants to talk to.

- (i.e. the memory location or the I/O device).
  - It is a one way bus: From the cpu!

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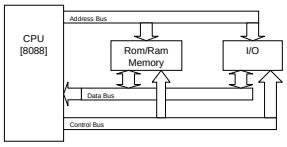
A Computer's Mother Board



- The Control "BUS" is a set of lines that act as the "traffic control" for the other two busses.

- These lines indicate such things as data direction (Read/Write), is data meant for memory or a peripheral device (I/O) and others.

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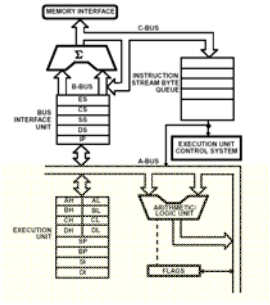
Inside the CPU



- Execution Unit which includes
  - Arithmetic Logic Unit (ALU)
  - Flags
  - Registers

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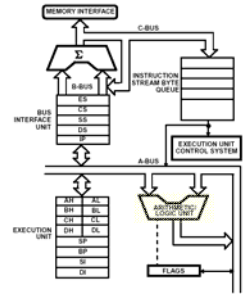
Inside the CPU



- The ALU
  - Does all the math and logic for the CPU
- Note the TWO lines coming off the A-BUS

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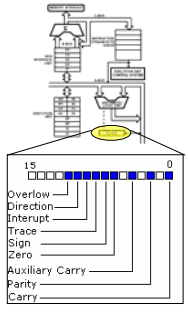
Inside the CPU



- The Flags
  - Indicate the status after a mathematical or logical instruction

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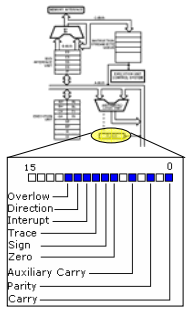
Inside the CPU



- The Flags
  - Checks for things like
    - Is the answer ZERO?
    - Is the answer Negative?
    - Does the overflow?

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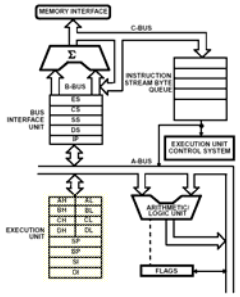
Inside the CPU



- Registers
  - Special memory locations inside the CPU.
  - Some register have special functions:
    - The AH and AL registers (a.k.a. **Accumulators**) are used for many math functions and are hard-wired into the ALU.

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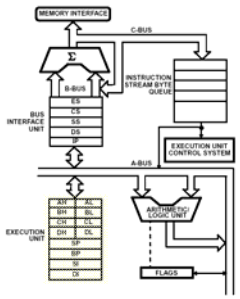
Inside the CPU



- Registers
  - Registers can be combined to create a 16bit register (8 bit registers AH and AL are combined to make a 16 bit register AX)

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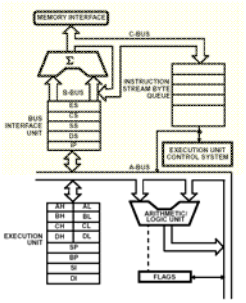
Inside the CPU



- Bus Interface Unit (BIU) includes
  - Execution control system
  - "Physical Address" calculator
  - Instruction Queue

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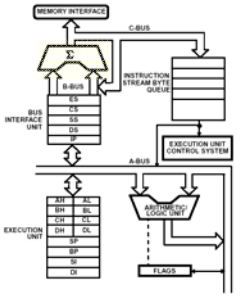
Inside the CPU



Physical Address Calculator
(The Dirty Little Trick to add Memory)

- The CPU is set up to handle 8 and 16 bit numbers, but to add more memory to the computer, the address bus is 20 bits wide. So how do we store a 20 bit number?

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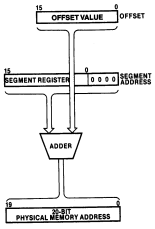
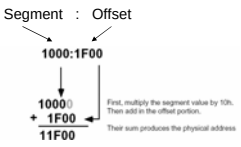
Segment / Offset -> Physical Address





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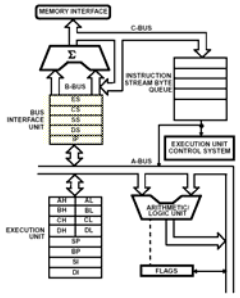
Inside the CPU



- Registers
  - Unlike the registers in the EU, these deal with Memory
  - ES, CS, SS, and DS are SEGMENT REGISTERS and are used for memory access using Segment:Offset (Mostly used for VERY LARGE PROGRAMS – over 64K)

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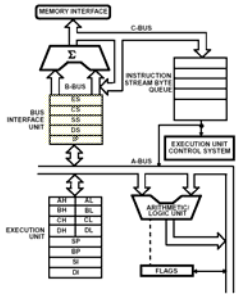
Inside the CPU



- Registers
  - IP is the instruction pointer and it hold the next memory location to execute (more on this latter)

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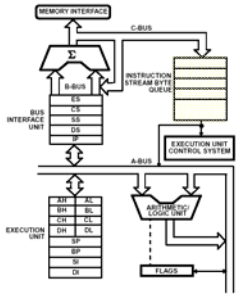
Inside the CPU



The Instruction Queue

Making your computer faster

Making CPU's Harder to understand

- BIU will pre-fetch memory locations (when it is not busy) and place them in the queue

WHY?

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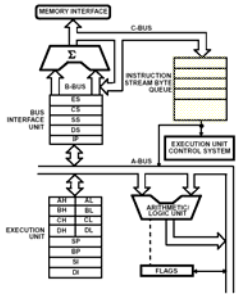
Inside the CPU



WHY?

- Memory access is relatively slow and occurs very often.
- If we can "READ AHEAD" in the program, we can execute programs faster
- Example: While the ALU is performing arithmetic we can look ahead and see what to do with the answer.
- Problem: What if we have to skip part of the program?

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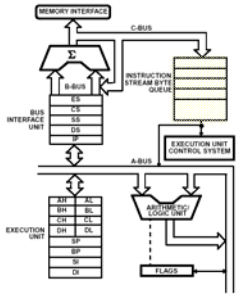
Inside the CPU



Example

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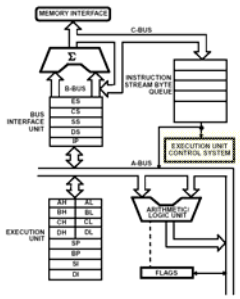
Inside the CPU



Execution Unit Control System

- Actually controls the execution of the program instruction.
- Sets up the ALU to perform the correct math/logic function when required.
- Dumps the Instruction Queue when the program does not execute in sequential order.

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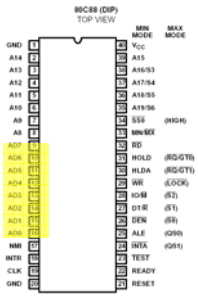
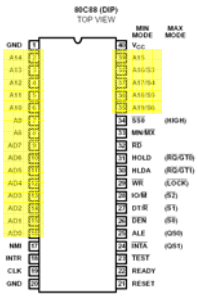
How does the CPU talk to devices on the Mother Board?

8088 PINS



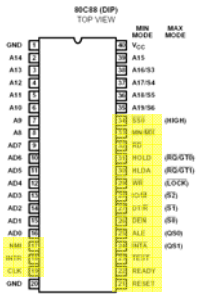
- Data BUS
  - Processors have pins typically marked D0…D7 that make up the data bus
  - The 8088 has pins AD0..AD7
    - These pins are MULTIPLEXED (some of the time they are data, some times address).
    - Must be demultiplexed (separated) using circuitry outside the CPU

8088 PINS



- Address BUS
  - Processors have pins typically marked A0…A*x* that make up the address bus
  - Again Remember the address bus on the 8088 is partially multiplexed

8088 PINS



- Control “BUS”
  - Multiple pins that control various functions
- Some Important Lines
  - CLK clock
  - Reset (control-alt-del)
  - ALE Address latch enable (used to demultiplex AD0..AD7 into D0..D7 and A0..A7)
  - IO/M indicates the cpu is talking to IO and Memory
  - RD and WR indicates the direction of the data bus (RD from memory, WR to memory)

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Some Notes

Pins marked with a bar over the pin name (i.e. $\overline{RD}$) indicate that that pin is active LOW.

Some pins are marked with a slash in the pin name (i.e. $IO/\overline{M}$). This gives the function of each state for clarity. In the case of the $IO/\overline{M}$ pin, when this pin is high the CPU is addressing and IO device. Conversely, when this pin is low, the CPU is addressing Memory.

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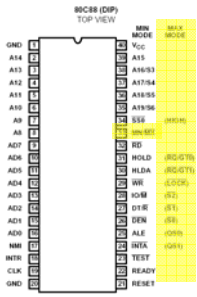
8088 PINS



- 8088 MIN/MAX Mode
- Processor can work two different ways.
- We will deal mostly with MIN mode
- MODE effects the function of some pins

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Why do we need ROM?

- Since computers run programs stored in memory, a computer just turned on doesn't have any programming to run. The CPU, upon a reset, is HARD WIRED to run the instruction at FFFF0H
- Since the instruction cannot be stored in RAM (upon turning off the computer all programs in RAM are lost), the start up instruction is stored in ROM along with the BOOT routines.

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Other Terms

- RISC - Reduced Instruction Set Computer
  - Runs a limited number of instructions
  - Fast
  - Typically used in embedded applications

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Other Terms

- CISC - Complex Instruction Set Computer
  - Many more instructions
  - Instructions do more complex functions
  - Used for PC's and other applications when flexibility and computational power are needed.
- The definition of RISC and CISC change over time (what was CISC at one point in time is now considered RISC and technology improves)

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Other Terms

- Microprocessor – a CPU that needs support IC's to operate. Typically CISC.

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Other Terms

- Microcontroller – a CPU with built in memory and IO capabilities. Typically RISC and used for embedded systems. Many only need a clock and power to operate.

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