# CpE 213
# Digital Systems Design
## 8051 Hardware Summary

Lecture 10

Wednesday 9/14/2005


UNIVERSITY OF MISSOURI-ROLLA

The Name. The Degree. The Difference.

# Overview

- Quiz
- 8051 Hardware Summary

# Introduction to 8051 Hardware

Some slides adapted from Mr. K. T. Ng and Dr. H. J. Pottinger

# Today's Lecture Content

- Understand the block diagram of the 8051 microcontroller (Chapter 4).
- Describe the various bus signals used by the 8051 microcontroller (Chapter 4).
- Will cover I/O port configurations in more detail in a later lecture.
- See Appendix H for data sheets.

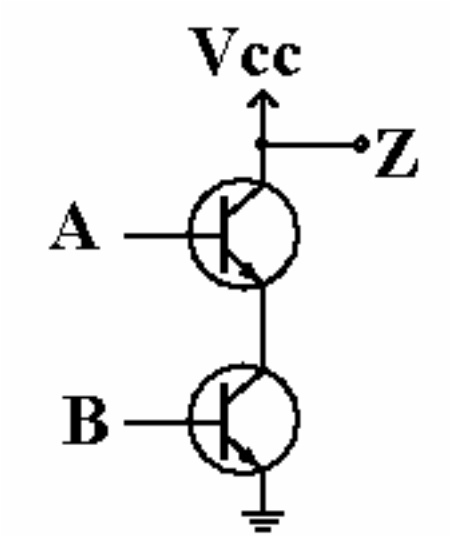
# Gains and Losses

| Microcontroller | Discrete Part |
| --- | --- |
| | Fast |
| Programmable | |
| | One specific task |

# Gains and Losses
# NAND example

Microcontroller

NAND2



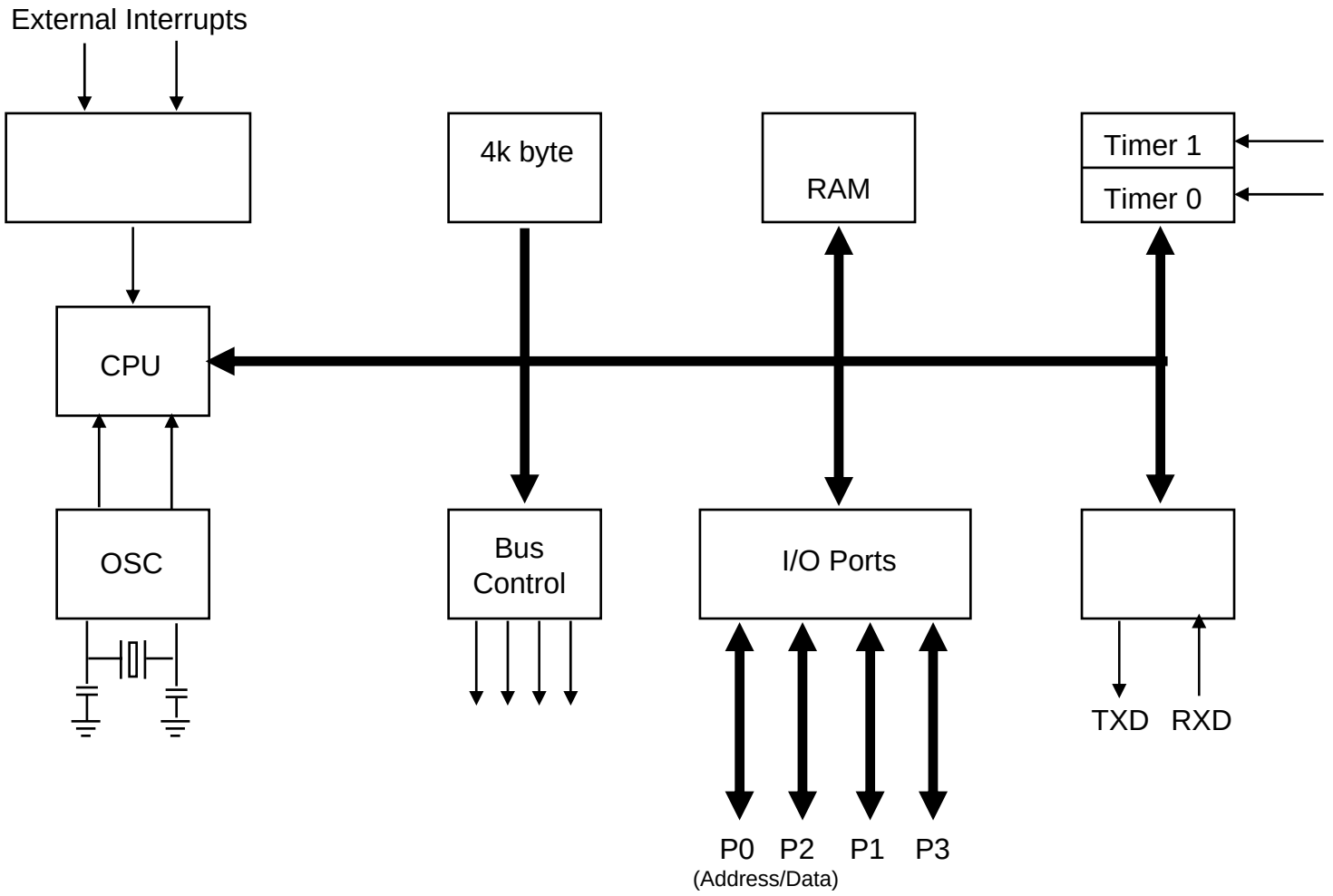
# 8051 Family

- 8051 introduced in 1980 by
- Second sourced by many vendors
- Competition from Motorola (  ) and Microchip (  )
- No such thing as ‘8051’
  - S87C751-1N24: OTP, 0-70°C, 24 pin PDIP
  - P89C51RD2BA: 64k Flash, 1k Ram, PLCC
  - See selection guide or ordering info for details

# Generic 8051 Features

- 0-  kB internal code ROM, EPROM, Flash
- bytes internal data RAM
- 8-bit I/O ports: P0, P1, P2, P3
- 16-bit counter/timers
- -addressable registers
- interface
- 64k external code and data address space
- MHz clock, 1 μsec cycle time

# 8051 Block Diagram



# 8051 Data Sheet

- Main source of microcontroller info.
- Available in pdf on vendors' websites.
- Selected datasheets in Appendix H of your textbook.
- See Blackboard for data sheet in standard format.

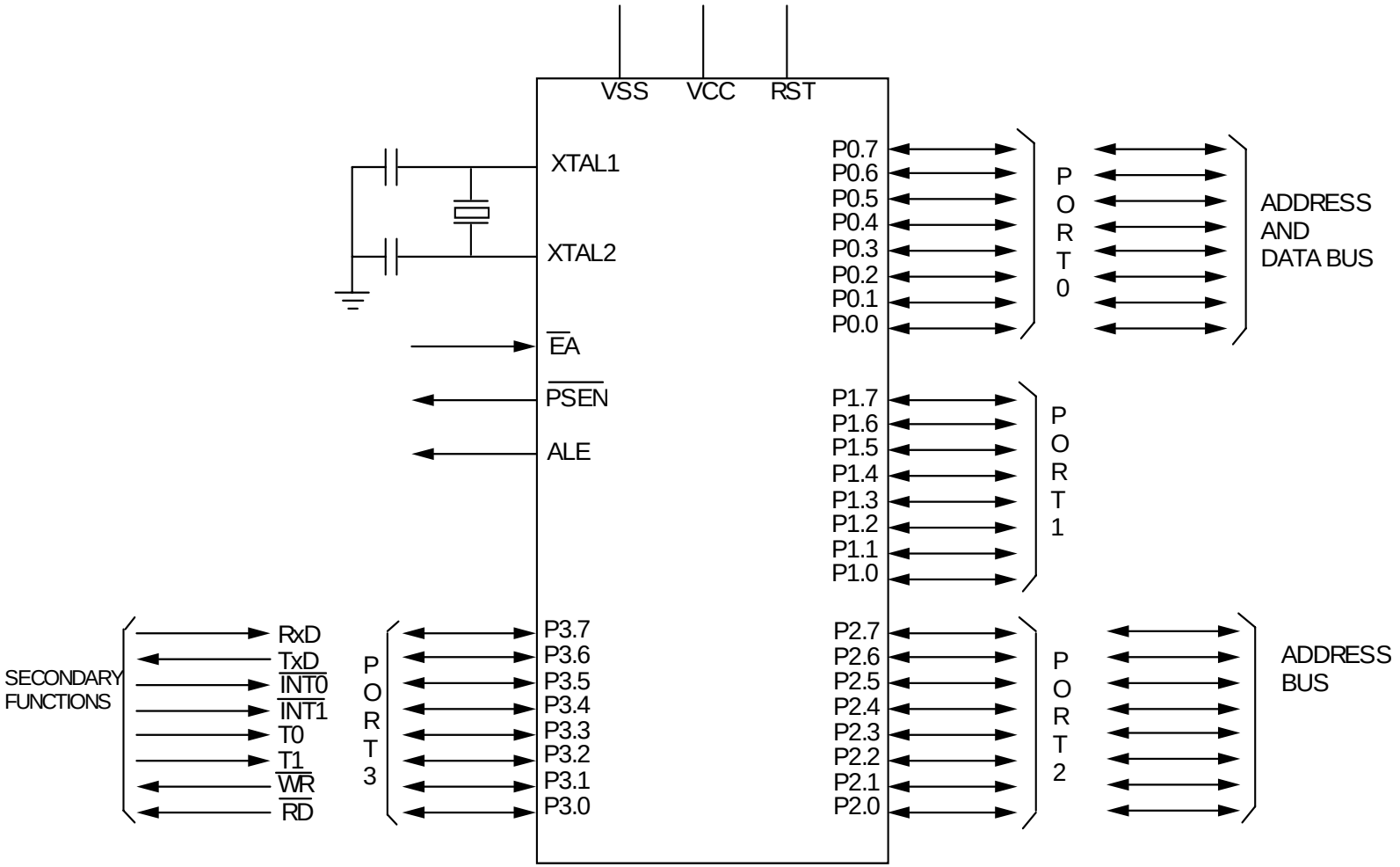
# 89C51Rx2 data sheet

- Features, ordering Info, packaging
- Block diagram
- Logic diagram
- Pinouts [note different packages]
- Pin descriptions [summary of pin functions]
- Alternate functions for Port
- Oscillator characteristics
- DC characteristics

# Intel 8051 Microcontroller

- An  -bit microcontroller optimized for applications.
- The  -pin package has a pin DIP (dual in-line package) layout (see next slide).
- A 44-pin square layout exists; more advanced members of the 8051 family have slightly different layouts.
- A 20-pin version with fewer I/O ports can be used for less demanding applications.

# 8051 Pin Diagram



# 8051 pins

- of lines function as I/O port lines.
  - of these lines are dual-purpose.
  - Can operate as I/O, control line, or part of data or address bus.
- lines in each port can be treated as a unit for interfaces (such as?)
- Each line can operate independently in interfacing to single-bit devices (such as?)

# 8051 I/O Ports

- P0: dual purpose
  - 
  - 
- P1: I/O port
- P2: dual purpose
  - 
  - 
- P3: dual purpose port
  - general I/O
  - each pin has alternate special features:

# Port 3 Alternate Functions

| Port Pin | Alternate Function |
|---|---|
| P3.0 | RXD (serial input port) |
| P3.1 | TXD (serial output port) |
| P3.2 | $\overline{\text{INT0}}$ (external interrupt 0) |
| P3.3 | $\overline{\text{INT1}}$ (external interrupt 1) |
| P3.4 | T0 (Timer 0 external input) |
| P3.5 | T1 (Timer 1 external input) |
| P3.6 | $\overline{\text{WR}}$ (external data memory write strobe) |
| P3.7 | $\overline{\text{RD}}$ (external data memory read strobe) |

# More on I/O Ports

- 32 pins for 4 8-bit ports
- At power-on all are ports by default
- To configure any port pin for input, write a 1 to that pin (will see how).
- Will study port operation in detail in a later lecture.

# 8051 pins

- Four dedicated bus control signals
  - 
  - 
  - 
  - 

# Bus Control Signals

## PSEN'

- Program Store Enable
- Enables external program (code) memory.
- Pulses during instruction state
- Usually connects to EPROM's pin

## ALE

- Address Latch Enable
- Used for de-muxing the address and data bus
- Pulses at 1/6$^{th}$ the oscillator frequency

# More Bus Control Signals

## EA’

- External Access
- Usually tied either
- If high, program executes from internal memory
- If low program executes from external memory only. PSEN’ needs to be low.

## RST

- Reset
- When high for 2 instruction/machine cycles, the micro-controller resets all internal registers, and begins a system reboot.
- Two methods for reset.

# 8051 Pins

## XTL1 & 2

- On-chip oscillator inputs.
- Can be driven by a crystal or by a TTL clock source, providing the clock signal for the micro-controller.
- Stabilization capacitors are sometimes required.

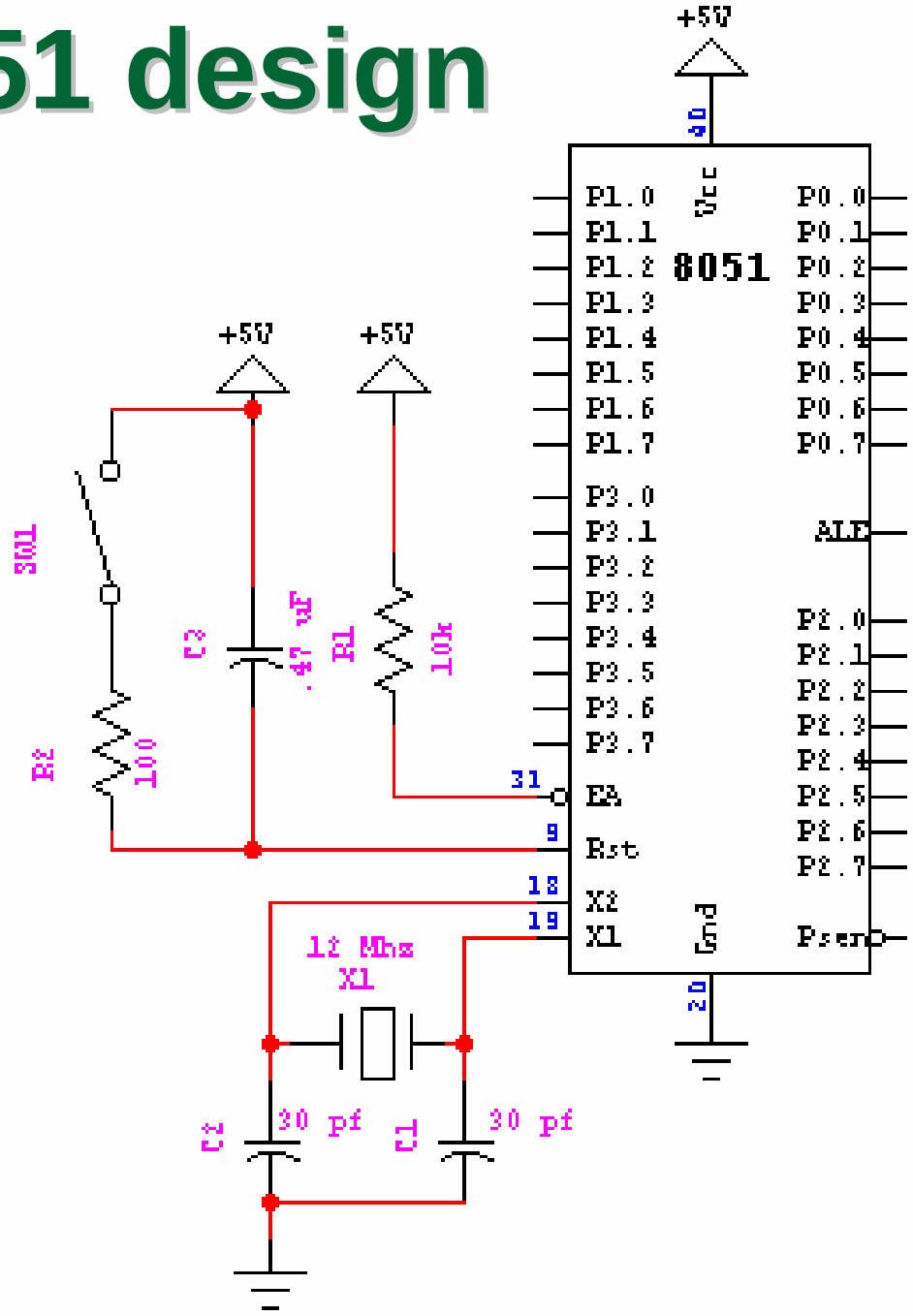
## $V_{cc}$

- Power in pin
- +2.5V to +6V
- Usually +5V

## GND/$V_{ss}$

- Ground pin

# A simple 8051 design



# 8051 Family Characteristics

- All members of the 8051 series share a common architecture.
  - 
- The essential differences among them are
  - 
  - 
  - 

# For Friday

- Finish assignment 3.
- Review today's lecture notes and Sections 4.1 and 4.2 of your textbook.
- Read Chapter 2.