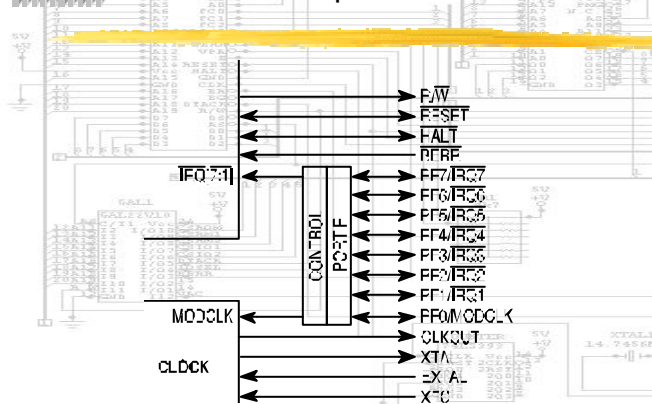


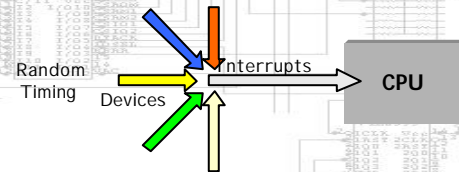
Interrupts



Control Bus Signals

- ▶ General signals for system operation.

- ▶ Example – Interrupt Signals
- ▶ Hardware I/O Device -> CPU
- ▶ Many devices driving one interrupt.

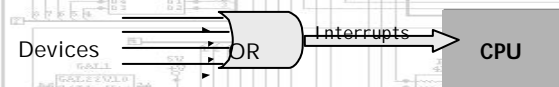


Random Timing

- ▶ A multiplexer with tristate outputs provide no answer for this situation.
- ▶ Observation
 - ▶ Interrupt is a "condition"
 - ▶ Either an interrupt is pending or it isn't.
 - ▶ We want to set the interrupt line if any device wants to interrupt.

MUX -> OR Gate

The Data bus Multiplexer becomes a OR Gate.



A "Wired-OR" represents a solution for this problem.

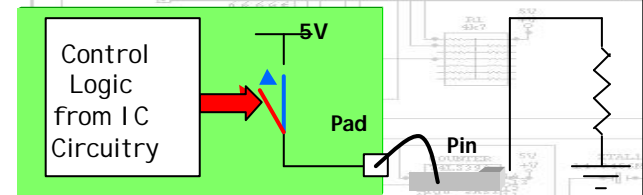
We have used tri-state devices as "Wired-MUX"!

Push/Pull Outputs (Partially Driven)

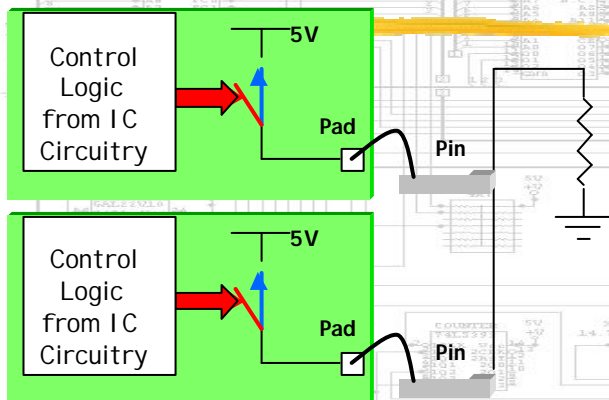
- ▶ Two flavours:
 - ▶ Pull-Down and Pull-Up (or Push-Up)
- ▶ Only force wire in one direction
 - ▶ "Driving" vs. "Relaxed"
- ▶ Need external resistor
- ▶ We can have any number driving at a time
 - ▶ Wired-OR & Wired-AND

Pull-up Pin Type

- ▶ Can connect an arbitrary no. of these to one signal wire.
- ▶ Wire also needs one pulldown resistor.
- ▶ -> "Wired-OR" (one or more switches closed = 1)



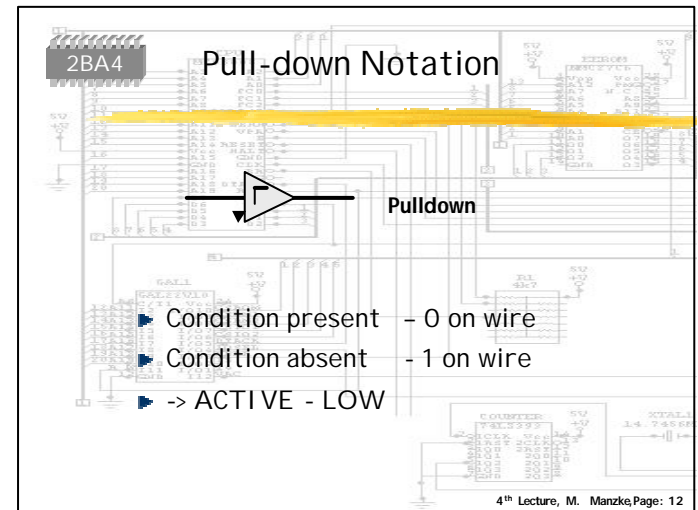
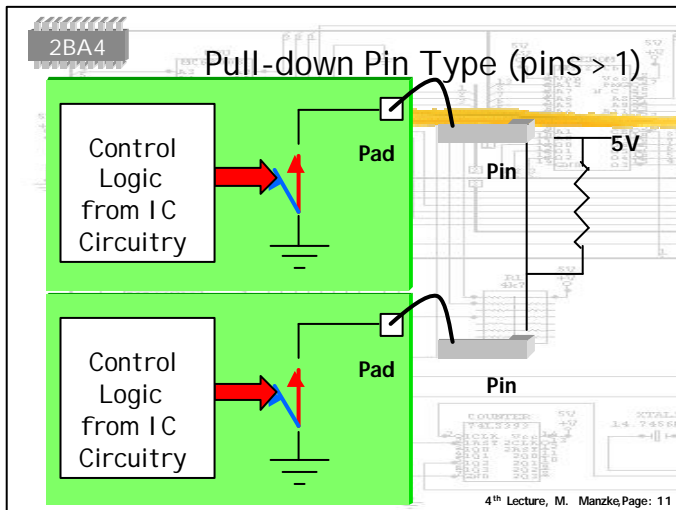
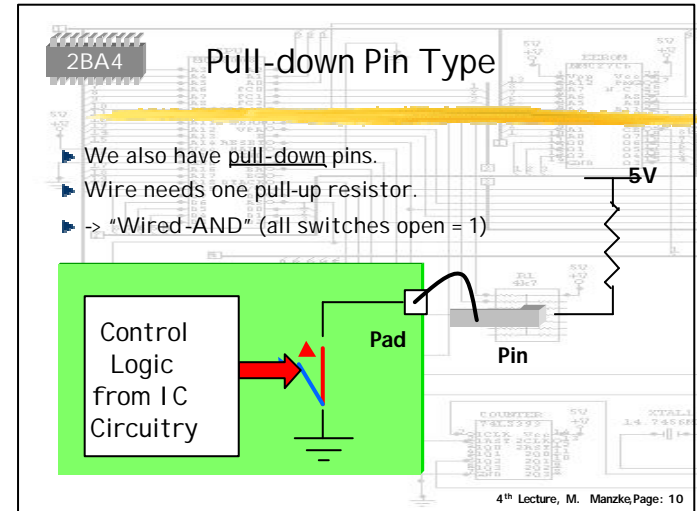
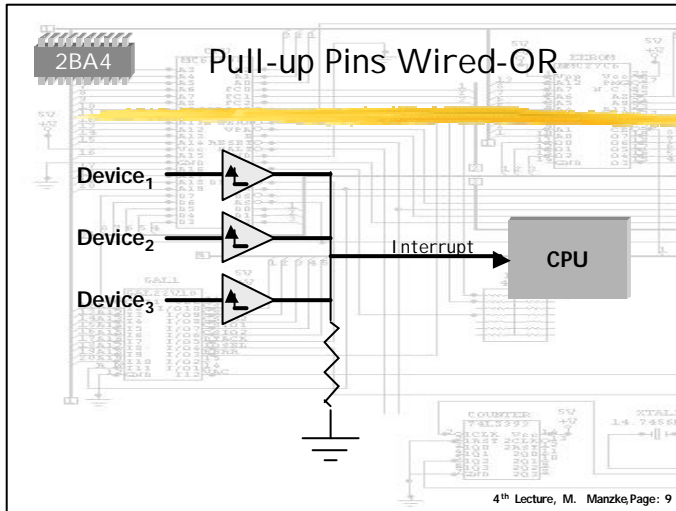
Pull-up Pin Type (pins >1)

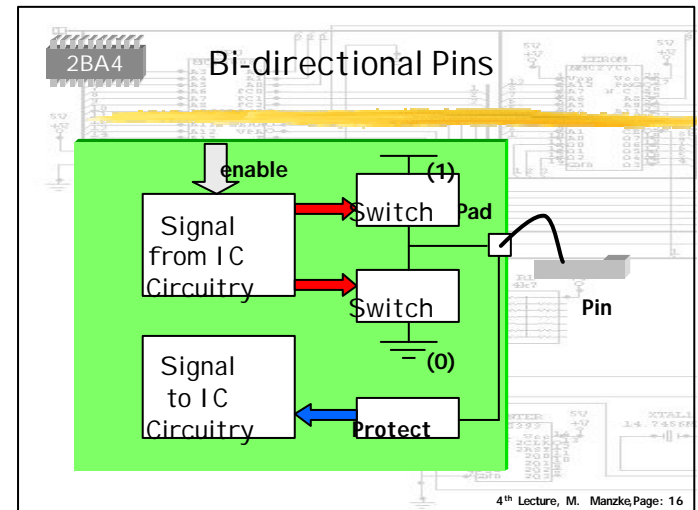
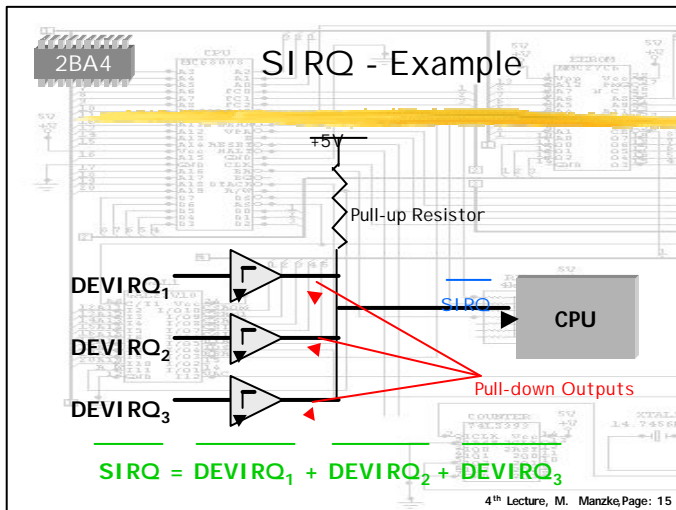
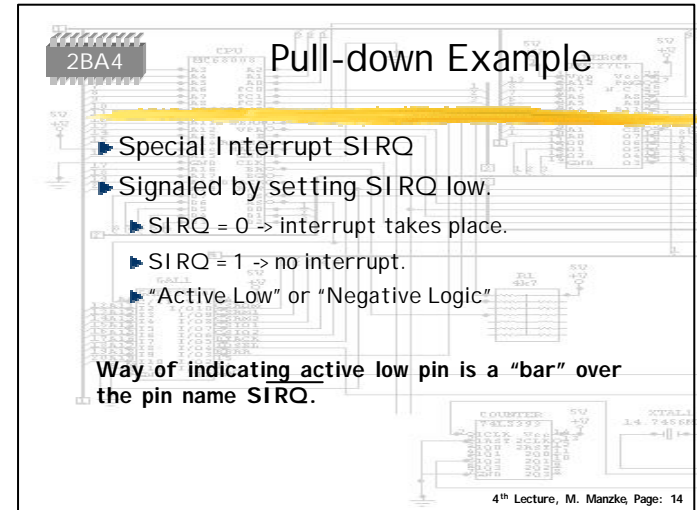
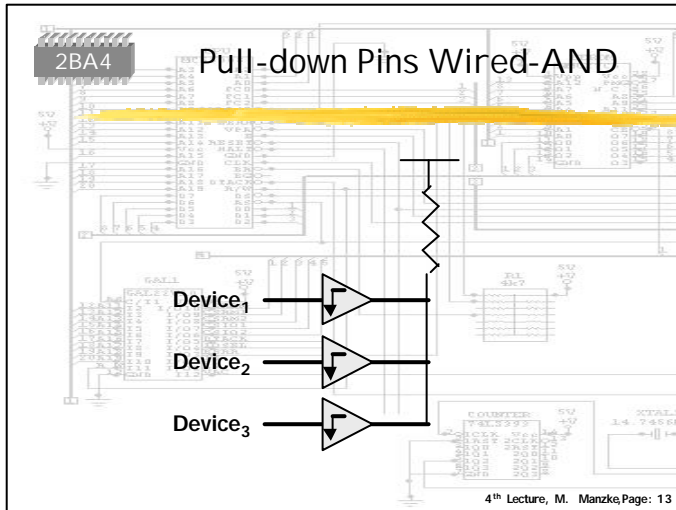


Pull-up Pin Notation

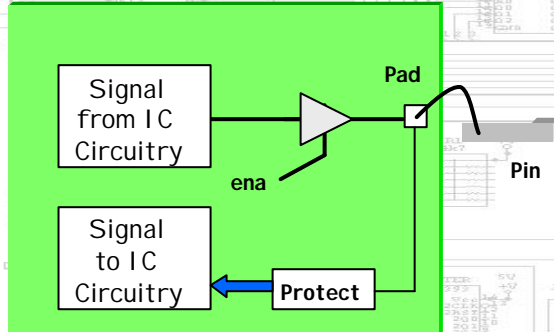


- ▶ Condition present - 1 on wire
- ▶ Condition absent - 0 on wire
- ▶ -> ACTIVE - HIGH



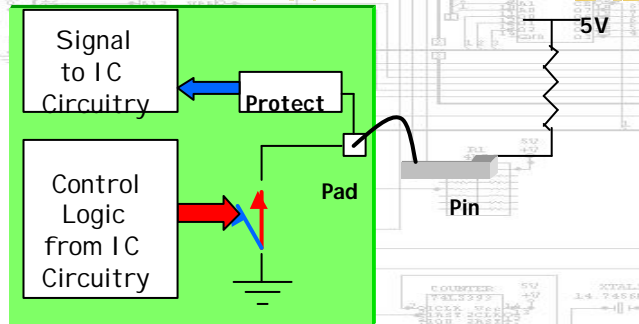


Tri-state Bi-directional Pins

Tri-state Bi-directional
(Data Bus Pins)

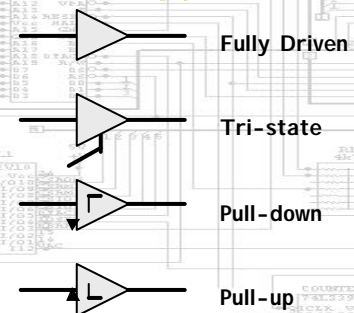
- ▶ Read:
 - ▶ ena is inactive
 - ▶ -> Output is "Hi-Z"
 - ▶ -> Pin acts as input
- ▶ Write:
 - ▶ ena is active
 - ▶ Pad is driven from chip.

Pull-down (up) Bi-directional



You don't get fully driven bi-directional pins.

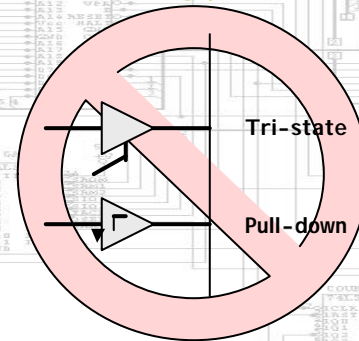
Output Pin Type Notation



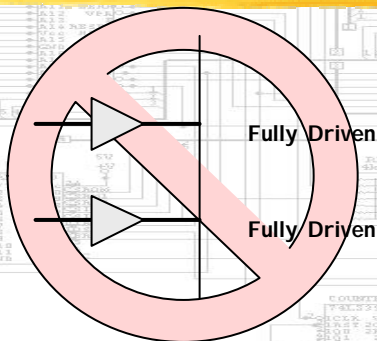
Pin Wiring Rules

1. Bi-directional pin obeys rules of its output type
2. To each wire we may attach:
 - 2.1 Only one output type.
 - 2.2 Only one fully driven output pin
 - 2.3.1 Many pull-down pins
 - 2.3.2 Any pull-down -> ONE pull-up resistor
 - 2.4.1 Many pull-up pins
 - 2.4.2 Any pull-up -> ONE pull-down resistor
 - 2.5 Many tri-state pins
 - 2.6 Only one driving tri-state pin at a time
 - 2.7 At least one input pin
 - 2.8 At least one output pin

2.1 Only one output type

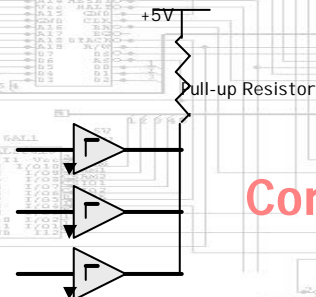


2.2 Only one fully driven output pin



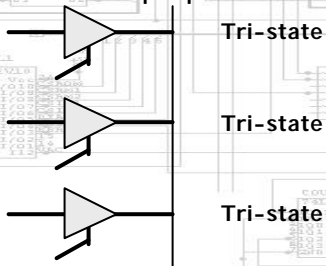
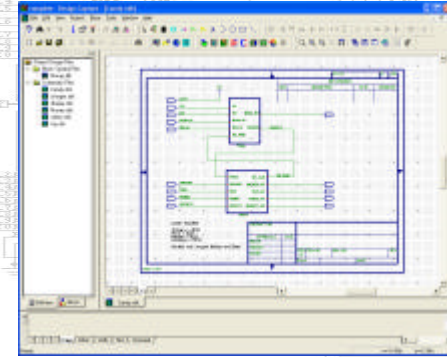
2.3.1 Many pull-down pins

2.3.2 Any pull-down -> ONE pull-up resistor



2.5 Many Tri-state pins

- 2.6 Only one driving tri-state pin at a time
- 2.8 At least one input pin
- 2.9 at least one output pin

Schematic with Mentor Graphics
Design Capture

Coursework

In order to achieve a good mark for your coursework you must provide a Mentor Graphics schematic drawing that reflects the current state of your system during every lab session (LG35). You should modify your schematic while your work on your system.