University of Strathclyde Engineering

Lecture 2
Part 1 – Basic I/O

EE579 Advanced Microcontroller Applications

Dr James Irvine, EEE

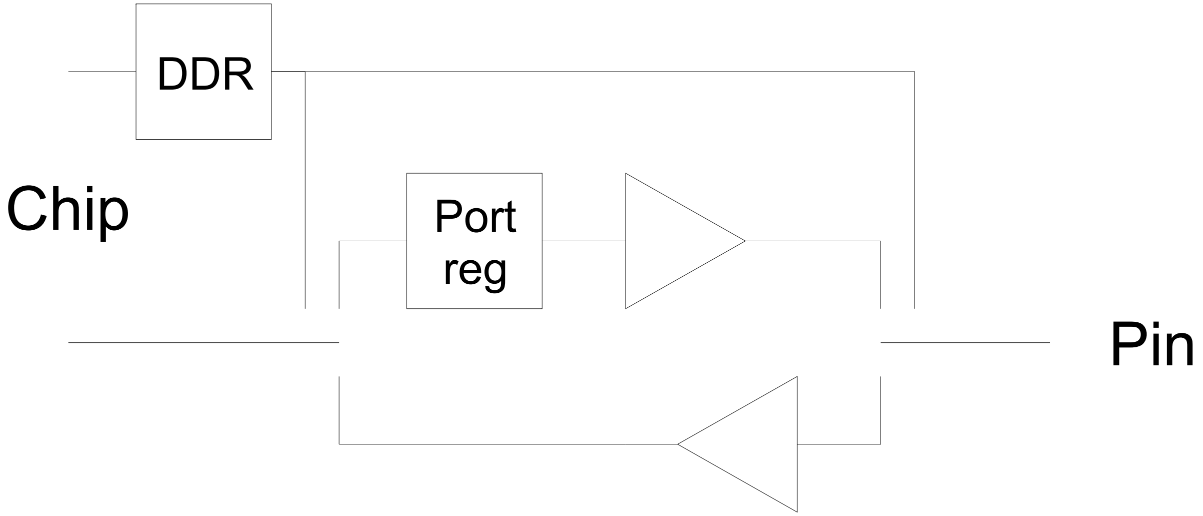
Basic I/O

I/O Ports

- I/O ports can be used as general purpose pins (GPIO) **or** through special functions
- Special functions include address, data and control lines for external memory, external interrupts, analogue I/O, serial I/O, clocks, etc
- Default is *usually* GPIO

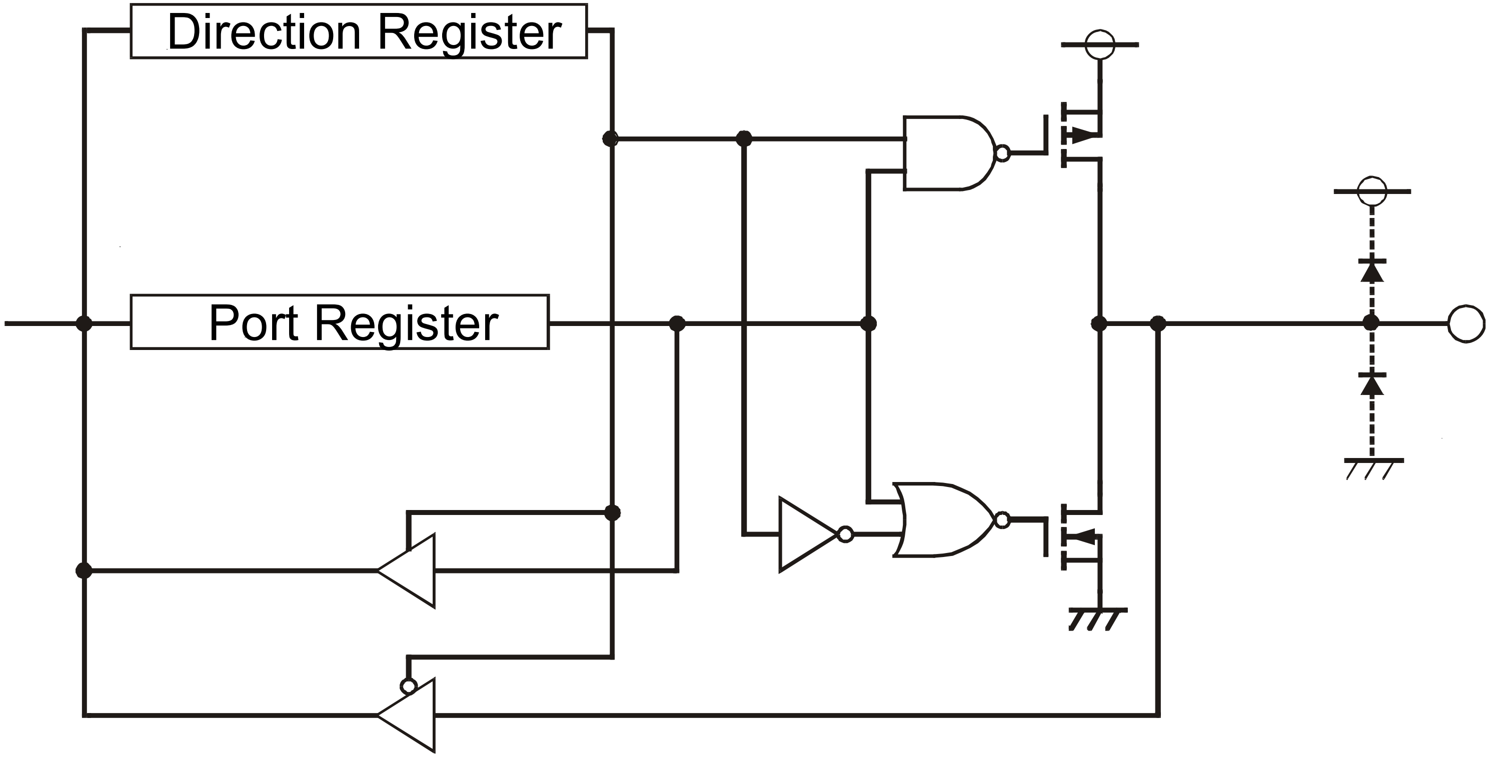
Basic I/O port

- Diagram of a ‘basic’ I/O port



- Usually a Data Direction Register (DDR) value of 0 activates the input buffer (so pins are inputs on reset)

Practical Implementation



Typical characteristics

- Most pins behave as standard MOS (low <0.5V, high > 2V, sink or source 10s of μA
- Some I/O pins may have open collector/drain outputs with or without pullups instead
- Often some of these pins can **sink** several milliamps, and drive LEDs directly
- Watch total chip dissipation limits - this **includes** current sunk from peripherals by the device

Basic I/O

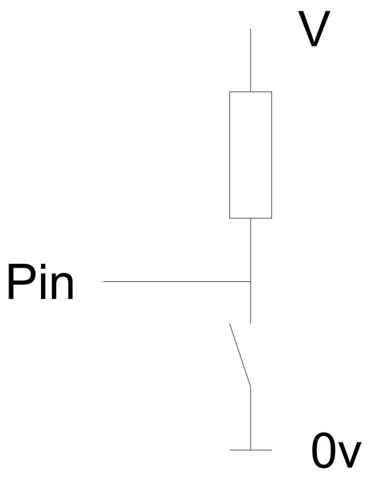
MSP430 I/O Ports

- Grouped in bytes as ports (P1.0, P1.1, etc)
- Multiple control registers, default to 0

Register	Function	Setting
PxDIR	Direction register	0 for input, 1 for output
PxIN	Input register	Value read at pin
PxOUT	Output register	Output register for output; Pull up/down for input (only is PxREN set)
PxSEL	Select register	Selects special function for pin, 0 for GPIO
PxREN	Resistor enable	Enables a weak (~35K) pull up/down when 1

Switches

- Simple switch connection is as follows

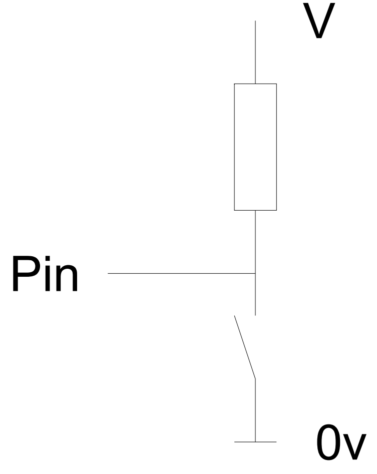


- Depressing the switch results in a ‘0’ at Pin
- Development system has one such switches connected to P1.3

Power Aware Switches

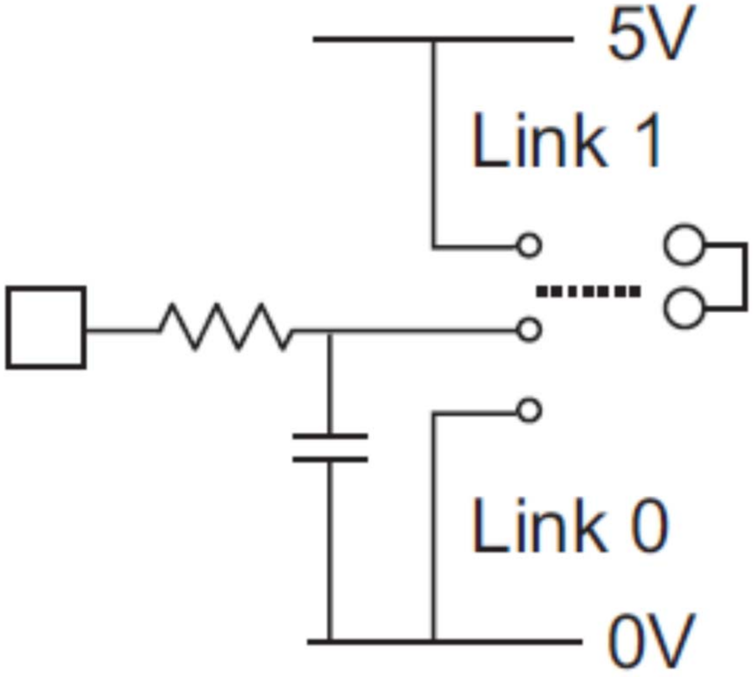
- Switch V from a GPIO
- Output 1 before reading the switch

- MSP430 has internal pullups
- Use them, and remember to switch them off!



Read Three States From One Pin

- To check state Z:
  - Drive output pin high
  - Set to Input
  - Read 1
  - Drive output pin low
  - Set to Input
  - Read 0
- To check state 0:
  - Read 0 on pin
- To check state 1:
  - Read 1 on pin
- **Never use 2 switches – could short!**



Gotchas

- **BEWARE** - on almost all designs, reading a port which is set for output will read the output register, not the pin, but reading from an input pin reads the pin
- This can cause odd happenings with read-modify-write functions (almost all bit operations)
- MSP430 safe, as two registers
- For special function pins (i.e. with option registers), take care of the order of updating registers to avoid forbidden states (which could cause damage to the device)