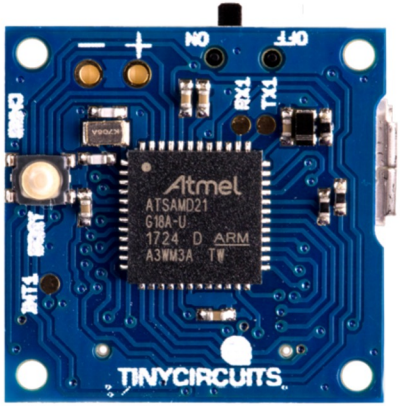
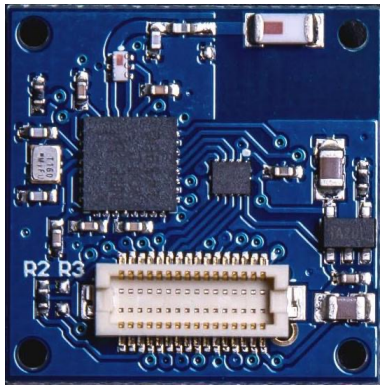
CSE190 Fall 2023



Lecture 14

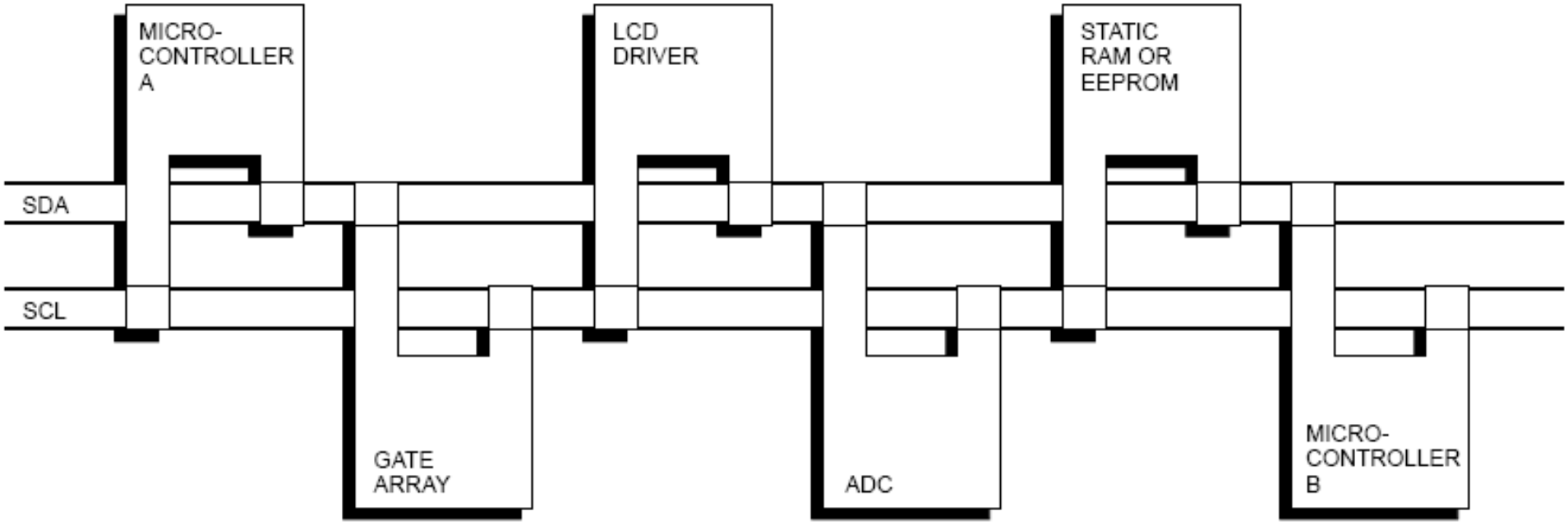
How to use I2C



Wireless Embedded Systems

Aaron Schulman

I2C-Connected System



Example I2C-connected system with two microcontrollers

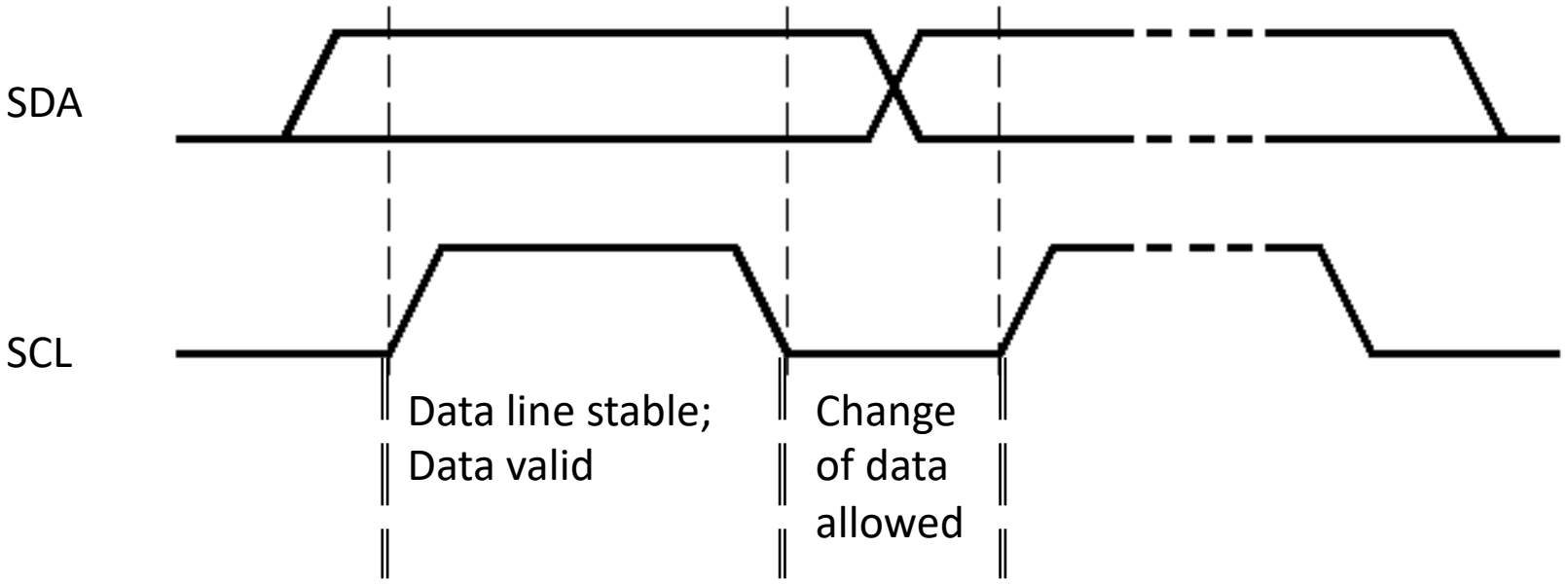
(Source: I2C Specification, Philips)

Primary/Secondary Relationships

- Who is the primary?
  - primary-transmitters
  - primary-receivers
- Suppose microcontroller A wants to send information to microcontroller B
  - A (primary) addresses B (secondary)
  - A (primary-transmitter), sends data to B (secondary-receiver)
  - A terminates the transfer.
- If microcontroller A wants to receive information from microcontroller B
  - A (primary) addresses microcontroller B (secondary)
  - A (primary-receiver) receives data from B (secondary-transmitter)
  - A terminates the transfer
- In both cases, the primary (microcontroller A) generates the timing and terminates the transfer

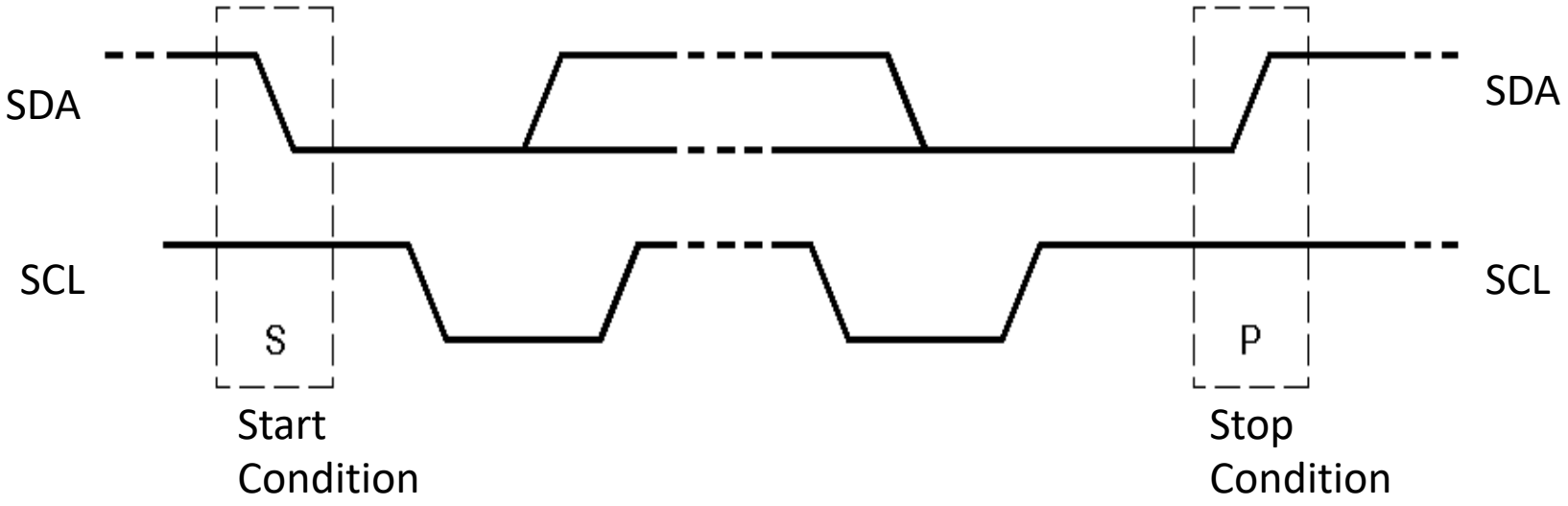
Bit Transfer on the I^2C Bus

- In normal data transfer, the data line only changes state when the clock is low



Start and Stop Conditions

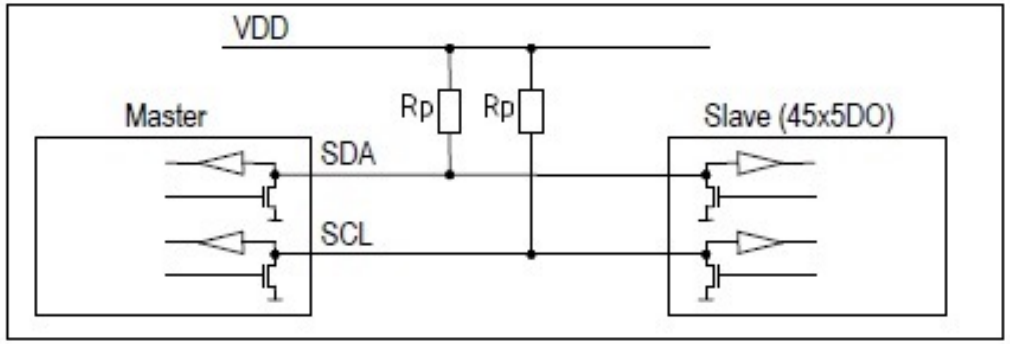
- A transition of the data line while the clock line is high is defined as either a start or a stop condition.
- Both start and stop conditions are generated by the bus primary
- The bus is considered busy after a start condition, until a stop condition occurs



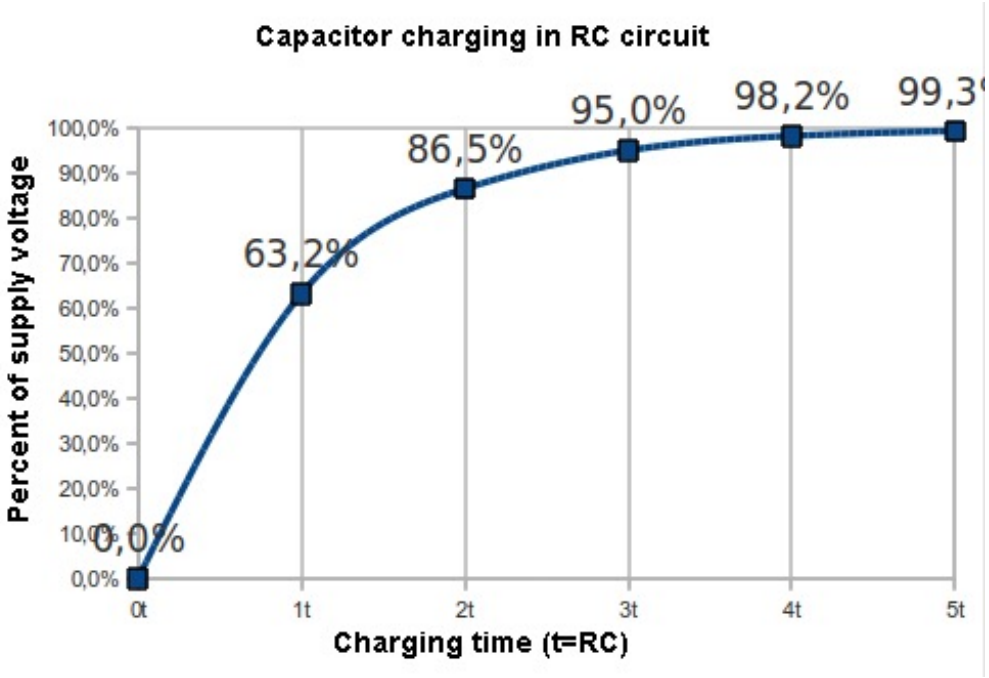
I^2C Addressing

- Each node has a unique 7 (or 10) bit address
- Peripherals often have fixed and programmable address portions
- Addresses starting with 0000 or 1111 have special functions:-
  - 0000000 Is a General Call Address – E.g. system reset
  - 1111XXX Address Extension
  - 1111111 Address Extension – Next Bytes are the Actual Address

How fast can I2C run?



- How fast can you run it?
- Assumptions
  - 0's are driven
  - 1's are "pulled up"
- Some working figures
  - R_p = 10 kΩ
  - C_{cap} = 100 pF
  - V_{DD} = 5 V
  - V_{in_high} = 3.5 V
- Recall for RC circuit
  - $V_{cap}(t) = V_{DD}(1-e^{-t/\tau})$
  - Where $\tau = RC$



Practically I2C can do at most 400kbps

Exercise: Bus bit rate vs Useful data rate

- An I2C “transactions” involves the following bits
  - <S><A6:A0><R/W><A><D7:D0><A><F>
- Which of these actually carries useful data?
  - <S><A6:A0><R/W><A><D7:D0><A><F>
- So, if a bus runs at 400 kHz
  - What is the clock period?
  - What is the data throughput (i.e. data-bits/second)?
  - What is the bus “efficiency”?