Inter-Integrated Circuit (I2C) Basics

also commonly called
Two Wire Interface (TWI)

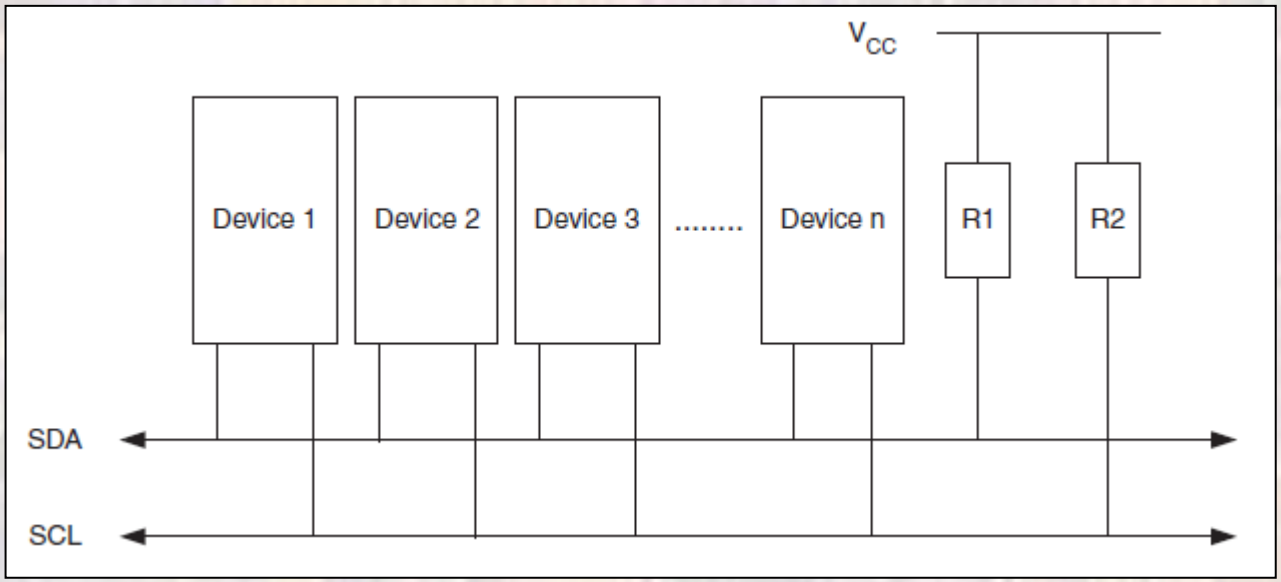
Last updated 6/21/21

I2C Basics

- Overview
  - 8 bit synchronous shift register used to communicate externally
    - 9 bit total communication packet
    - uni-directional
  - Most often used to communicate with peripherals
    - displays, sensors, converters
  - Supports multiple masters and multiple slaves
  - 4 modes of operation
    - Master Receive
    - Master Transmit
    - Slave Receive
    - Slave Transmit

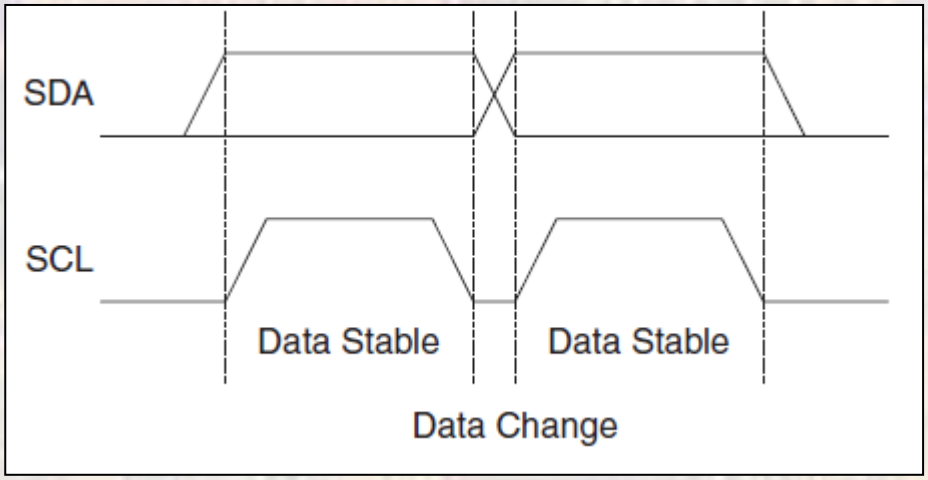
I2C Basics

- Overview
  - Open drain configuration
    - outputs only pull down
    - pull up resistors or current sources pull up



I2C Basics

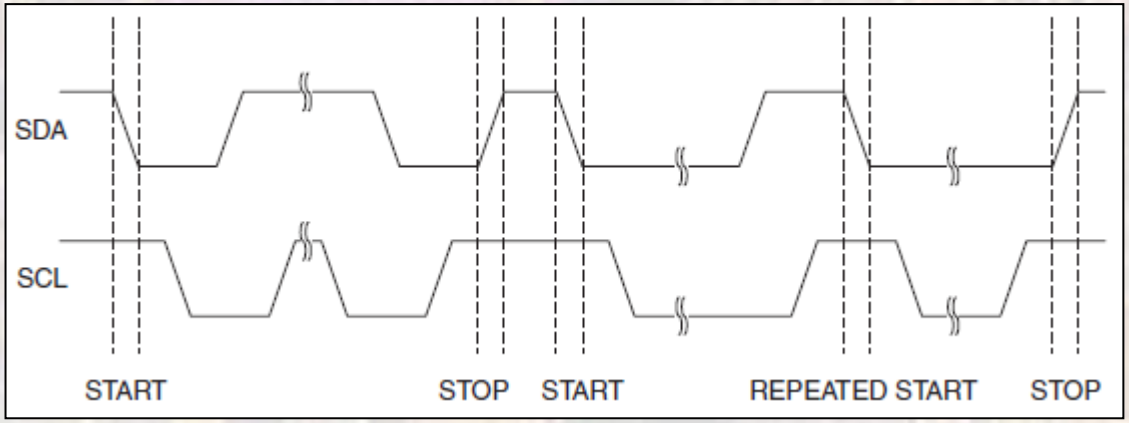
- I2C Timing
  - SDA – data line
  - SCL – clock line
  - Data must be valid during the entire positive clock cycle time



Note: data changes occur during SCL low

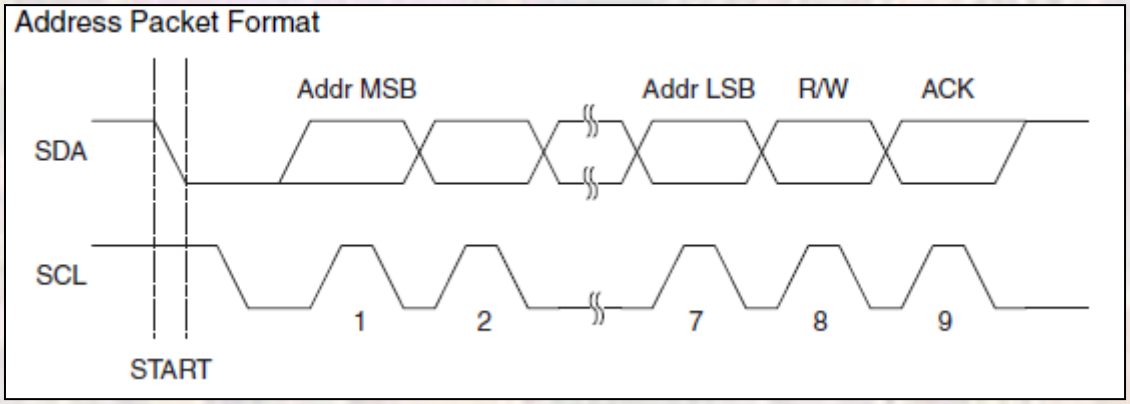
I2C Basics

- I2C Timing
  - Special timing requirements for
    - start transmission
    - stop transmission
    - repeated start transition
      - master does not relinquish the bus in this mode



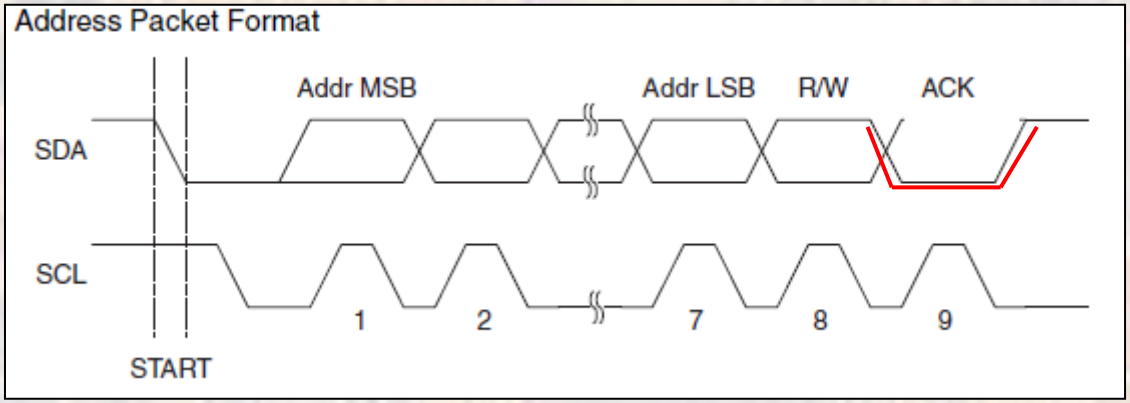
I2C Basics

- I2C Timing
  - Addressing
    - Indicate which slave to transmit to or receive from by first transmitting the “address” of the desired device
    - Often this value is hardwired via external pins on the slave device
    - 7 bits for each address



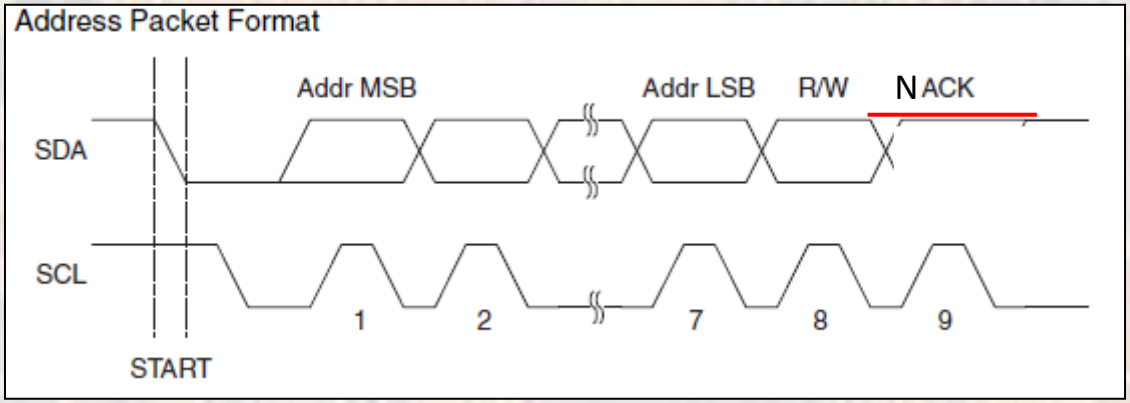
I2C Basics

- I2C Timing
  - R/W bit indicates a read or write operation is to follow
    - Read is active high
  - ACK - Acknowledge
    - The master drives the data bus from start through the R/W bit and then releases the bus
    - The slave then pulls down the bus in the last clock cycle to indicate a completed transmission



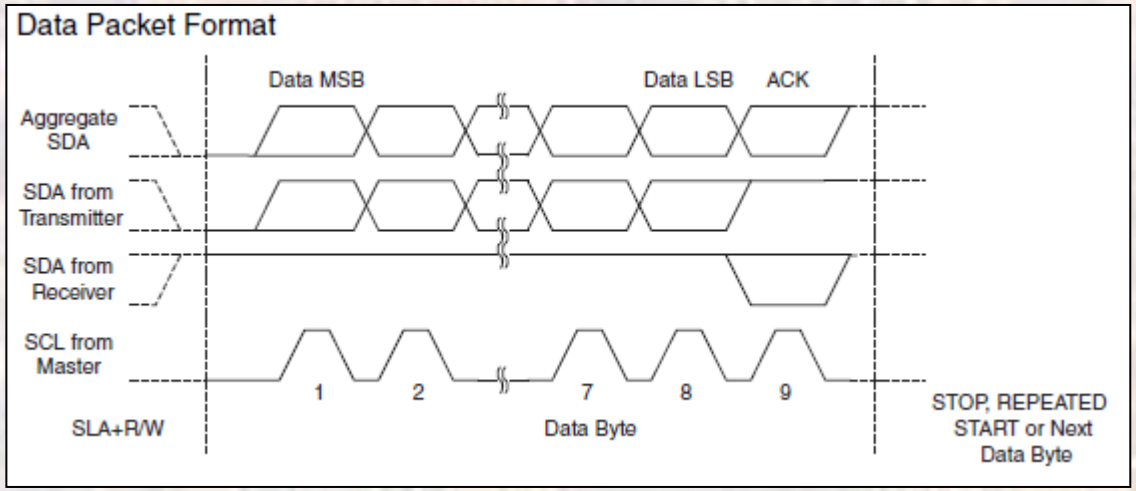
I2C Basics

- I2C Timing
  - ACK – cont'd
    - If the master fails to see the slave pull down the bus in the 9th clock cycle (NACK) – no acknowledge
      - Transmission failed
      - Some sort of error action is required



I2C Basics

- I2C Timing
  - Data packet
    - After getting an ACK on the address – data can be sent
    - 8 bits of data
    - 1 bit for a data ACK
    - This can be repeated many times



I2C Basics

- Multi-Master Arbitration
  - First master that attempts to transmit a 1 when the other transmits a 0 – loses arbitration and shuts off