Logic Levels

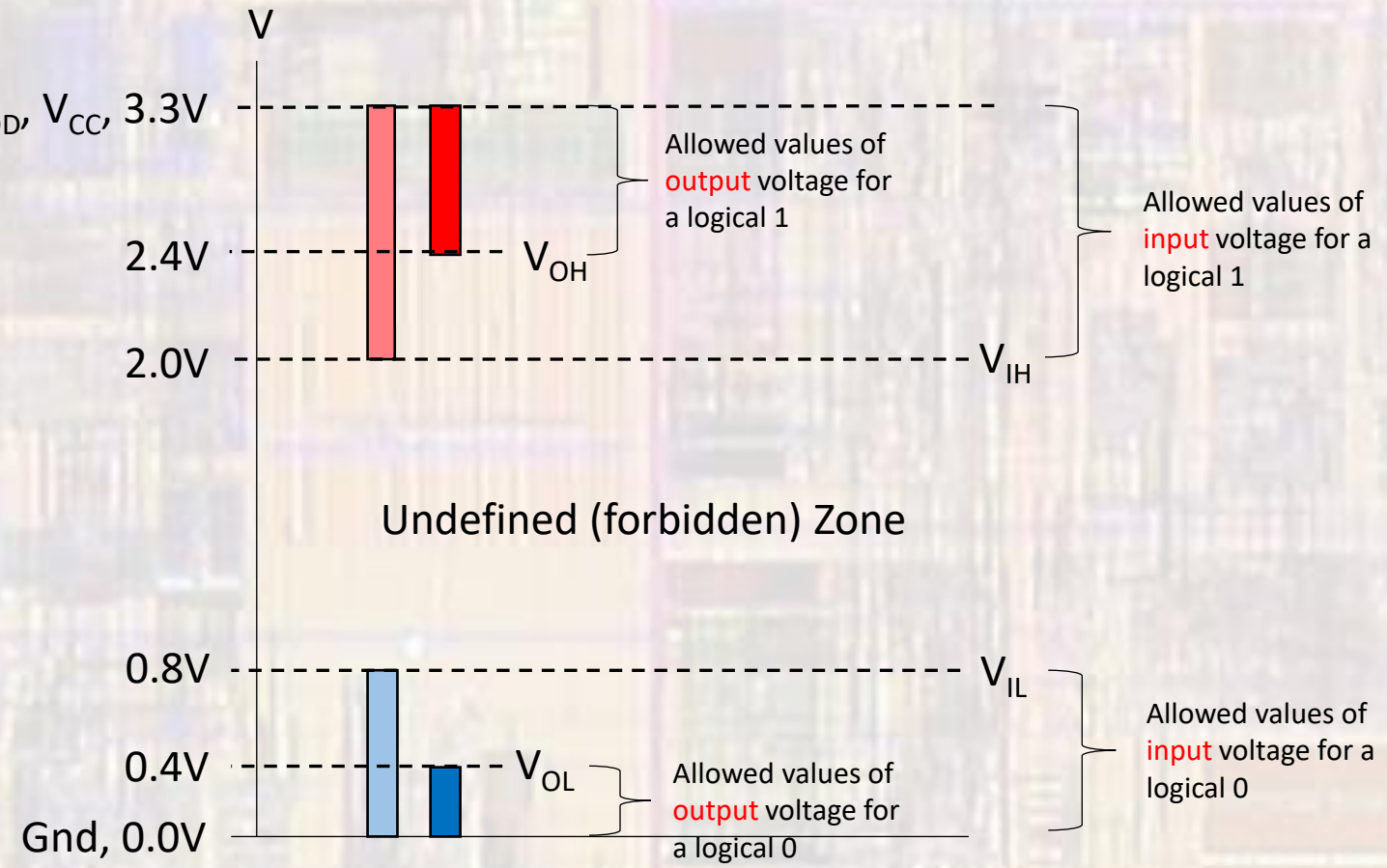
Last updated 1/6/25

Logic Levels

- Logic levels
  - The voltages on the inputs and outputs of logic gates that cause them to operate properly
    - Input Logic Levels
      - V_{IL} – Voltage Input Low
        - The largest voltage on the input of a logic gate that the gate guarantees to see as a logic 0 input
      - V_{IH} – Voltage Input High
        - The smallest voltage on the input of a logic gate that the gate guarantees to see as a logic 1 input
    - Output Logic Levels
      - V_{OL} – Voltage Output Low
        - The largest voltage on the output of a logic gate that represents a logic 0 output
      - V_{OH} – Voltage Output High
        - The smallest voltage on the output of a logic gate that represents a logic 1 output

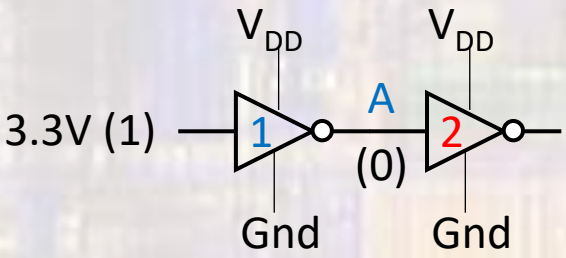
Logic Levels

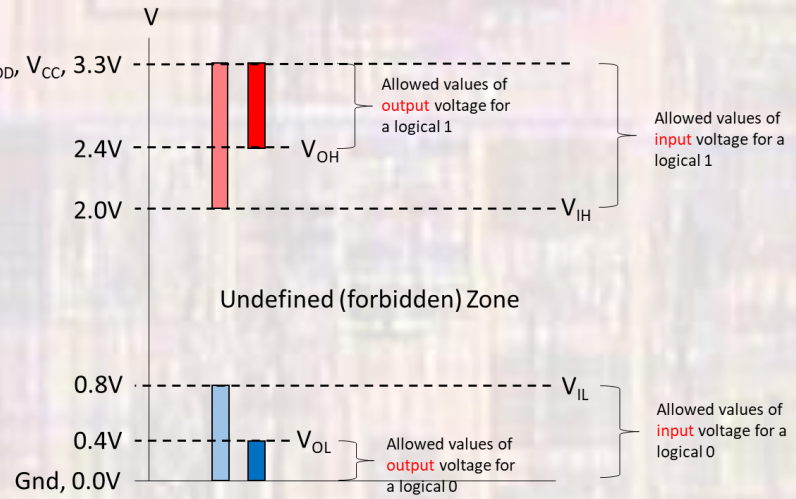
- 3.3V Example



Logic Levels

- 3.3V Example





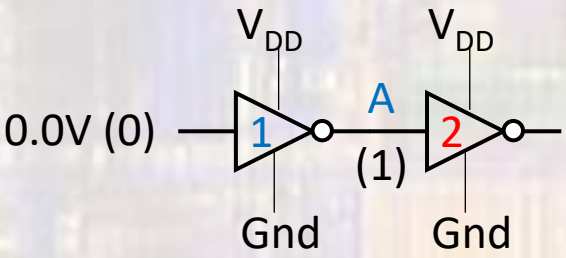
Inverter 1 guarantees the output voltage at A will be no more than 0.4V

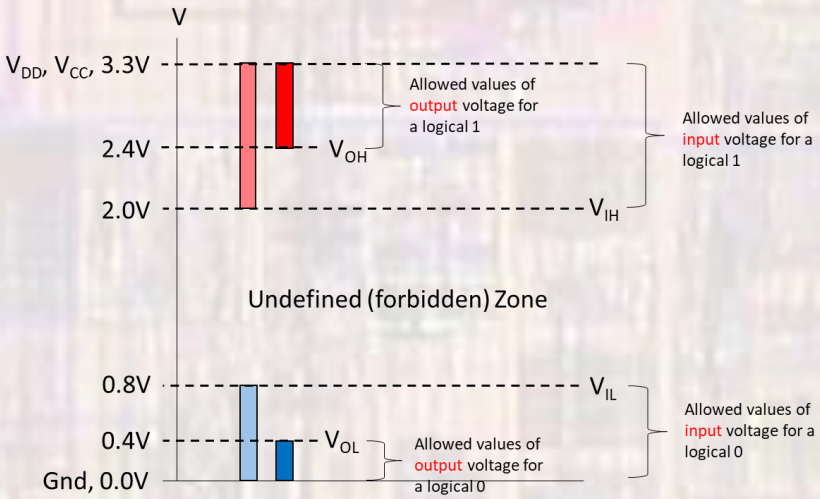
Inverter 2 guarantees to accept any voltage at A that is less than 0.8V will be seen as a 0

This leaves 0.4V of margin for error in the gates 'guarantees' → Noise margin

Logic Levels

- 3.3V Example





Inverter 1 guarantees the output voltage at A will be no less than 2.4V

Inverter 2 guarantees to accept any voltage at A that is more than 2.0V will be seen as a 1

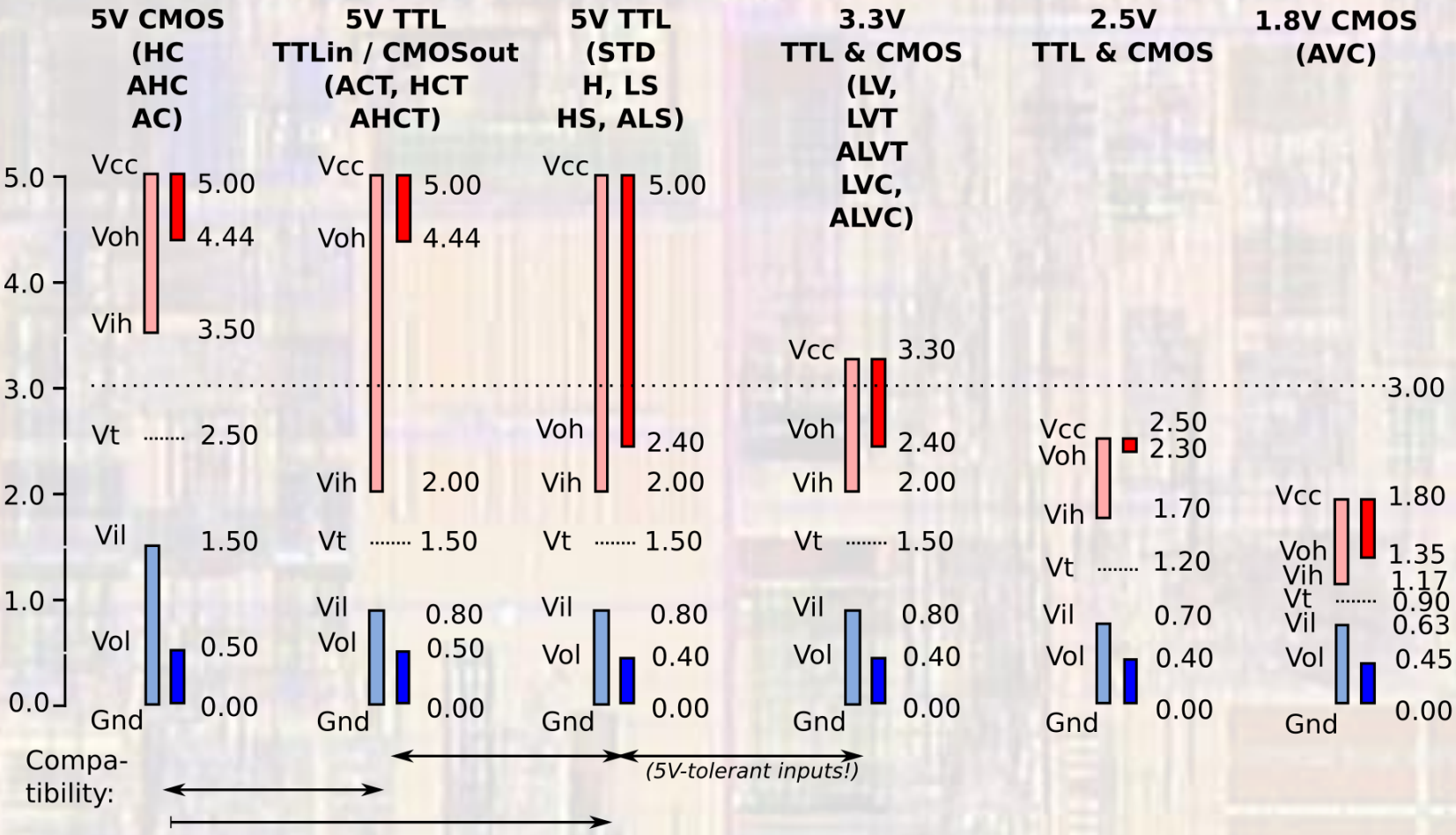
This leaves 0.4V of margin for error in the gates 'guarantees' → Noise margin

Logic Levels

- Noise Margin
  - The voltage difference between
    - V_{OH} and V_{IH} NM_{High}
    - V_{OL} and V_{IL} NM_{Low}
  - Common issues with the 'guarantees' of the logic gates
    1. Supply voltage variations
    2. We have greatly simplified out logic gates, some gates require current at the inputs. This input current causes a voltage drop inside the driving gate, reducing the output voltage
       - Limits the number of gates that can be driven

Logic Levels

- Common Technology Logic Levels



Data source: EETimes, A brief recap of popular logic standards (Mark Pearson, Maxim).