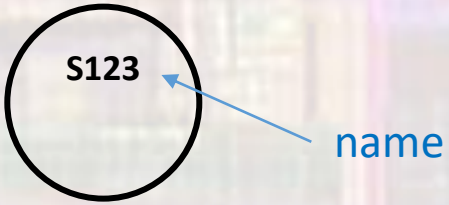
State Diagrams

Last updated 7/18/23

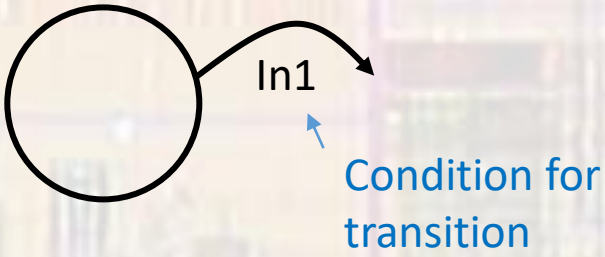
State Diagrams

- State Diagram Elements
  - State



  - Outputs

  - Inputs



State Diagrams

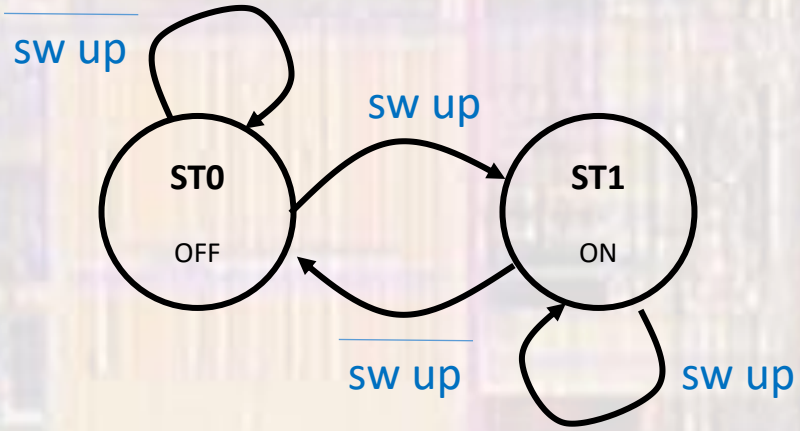
- Transition Rules
  - Transitions ONLY occur on clock edges (rising)
  - Transitions occur on EVERY clock edge (rising)
  - Only 1 path out of a state can be valid at a time
  - Every valid state must have an input path
  - Every valid state must have an output path
    - Note that the output path may point back to the originating state

State Diagrams

- Example 1
  - Light Switch – states

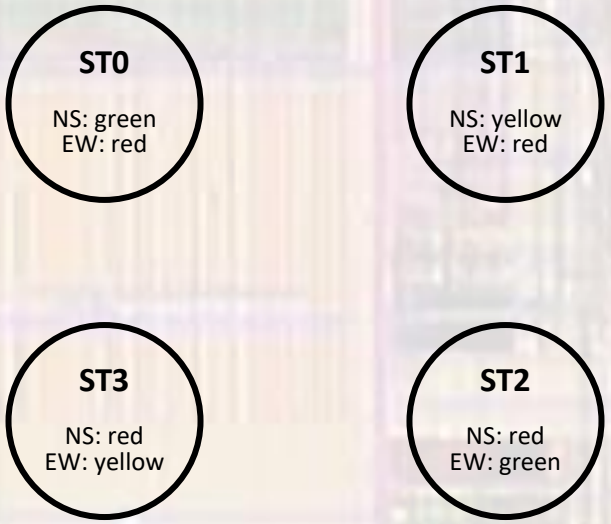
State Diagrams

- Example 1
  - Light Switch – transitions
    - Conditional – switch state is input



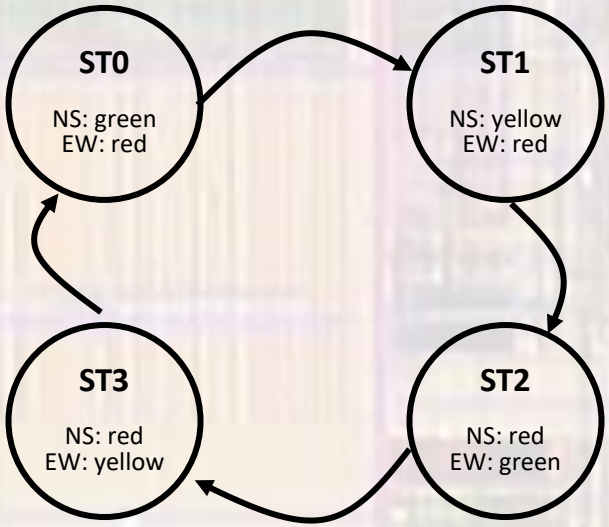
State Diagrams

- Example 2
  - Stoplight - states



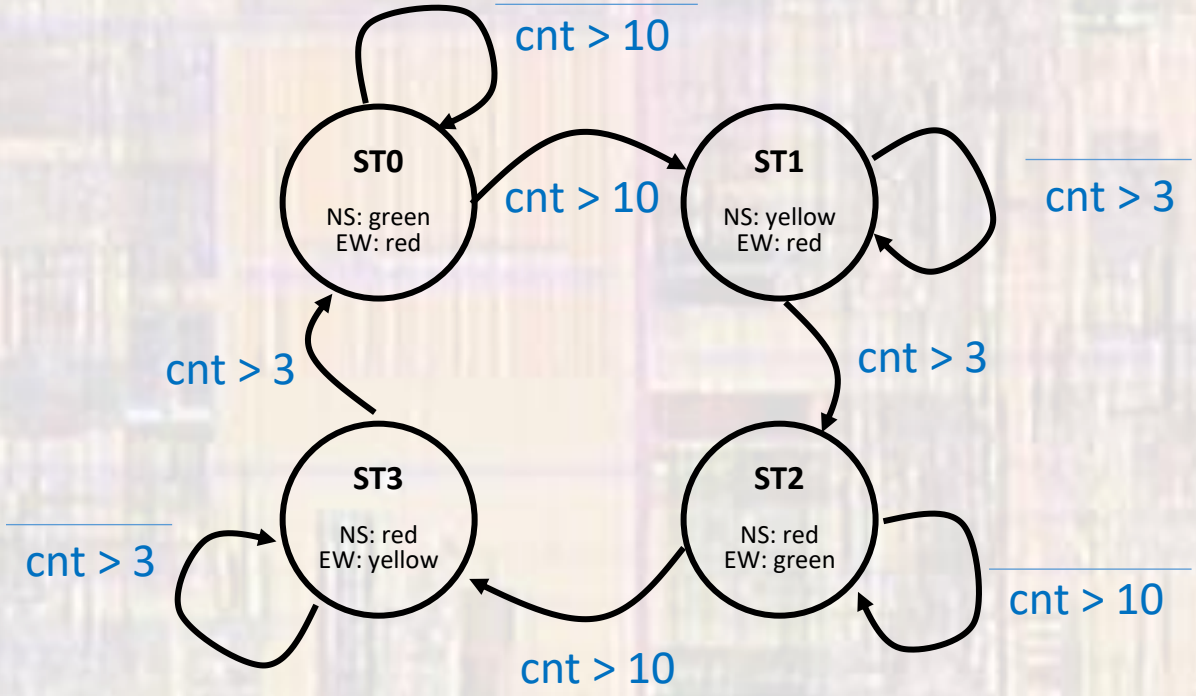
State Diagrams

- Example 2
  - Stoplight – transitions
    - Un-conditional – all signals active the same amount of time



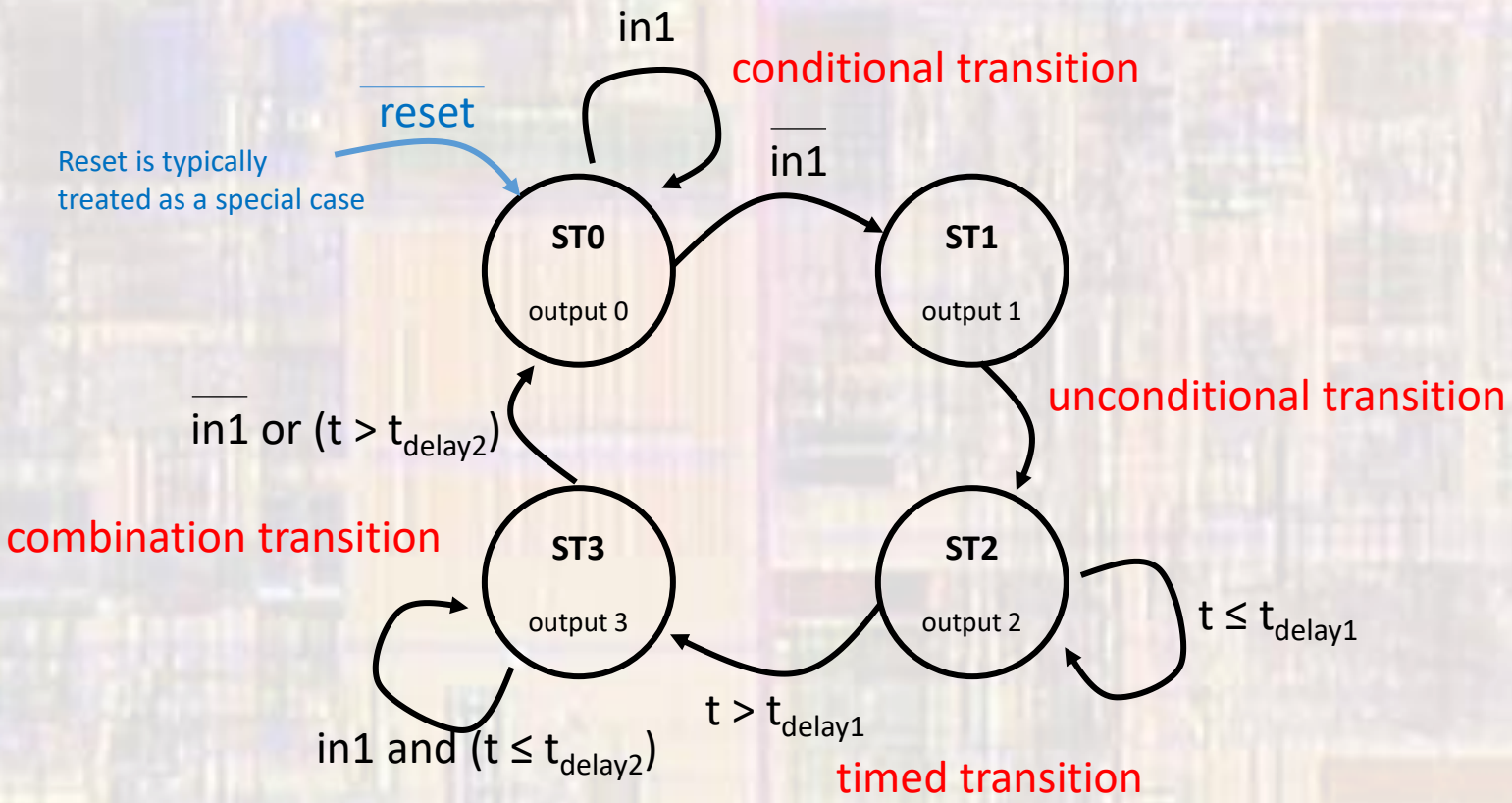
State Diagrams

- Example 2
  - Stoplight – transitions
    - Conditional – signals active different amounts of time
      - Use a counter to delay transitions



State Diagrams

- Types of Transitions



State Diagrams

- Un-used states
  - Do we care about un-used states?
  - YES!
  - Start-up
  - Bit errors

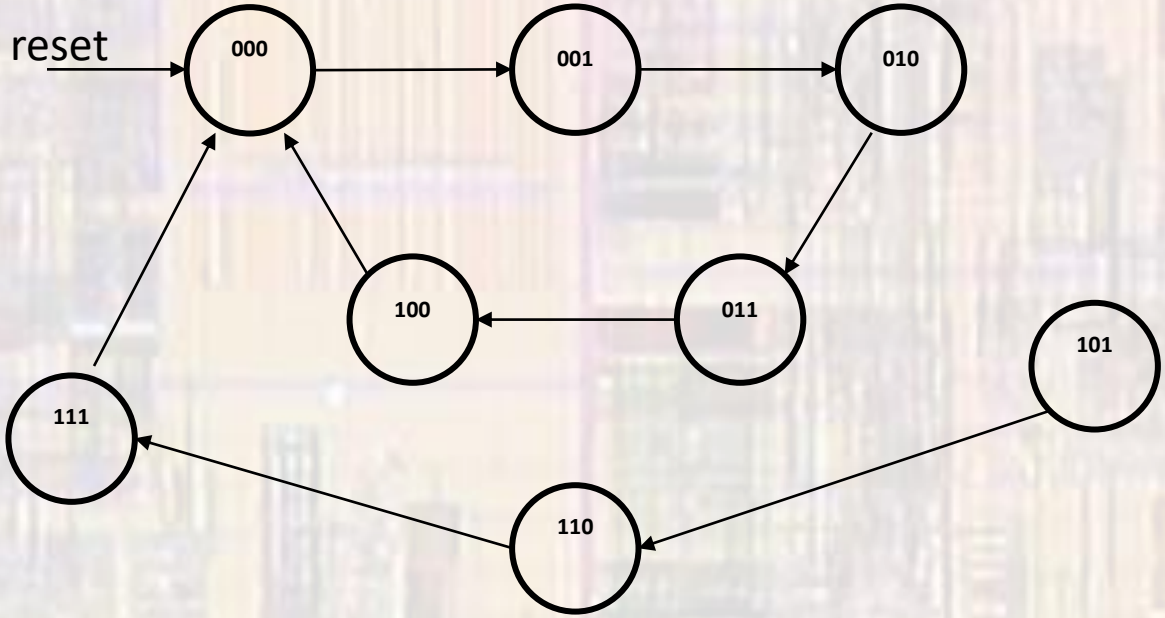
State Diagrams

- Un-used states
  - Mod 5 counter
    - Unconditional transitions
    - What happens if some error causes the count to be invalid?

With no plan – invalid states effectively point back to themselves

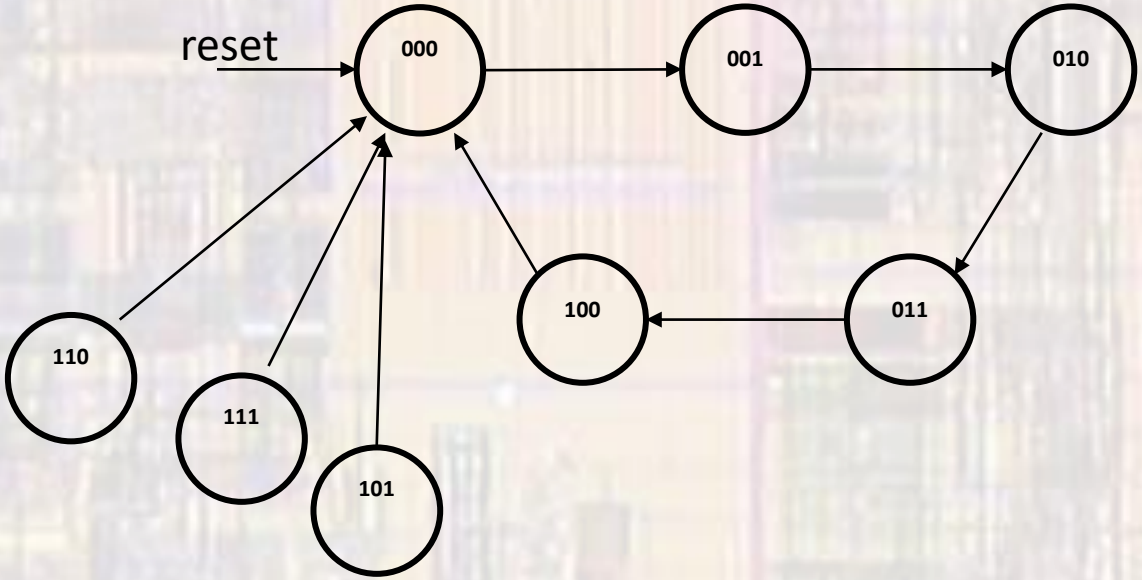
State Diagrams

- Un-used states
  - Mod 5 counter
    - Recovery solution 1



State Diagrams

- Un-used states
  - Mod 5 counter
    - Recovery solution 2

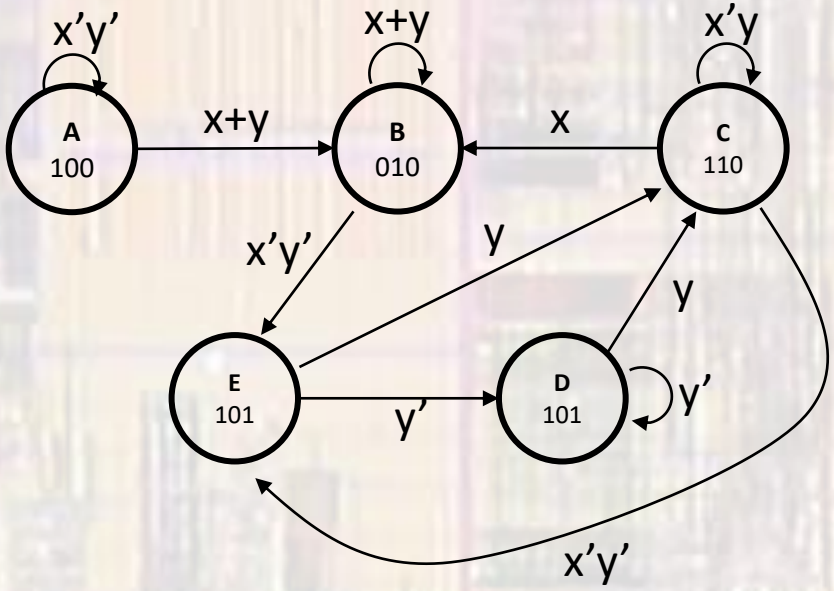


State Diagrams

- Redundant / Equivalent States
  - Redundant states lead to more logic than necessary
  - 2 States are equivalent if
    - Outputs are the same
    - Transition to the same next state if the inputs are the same

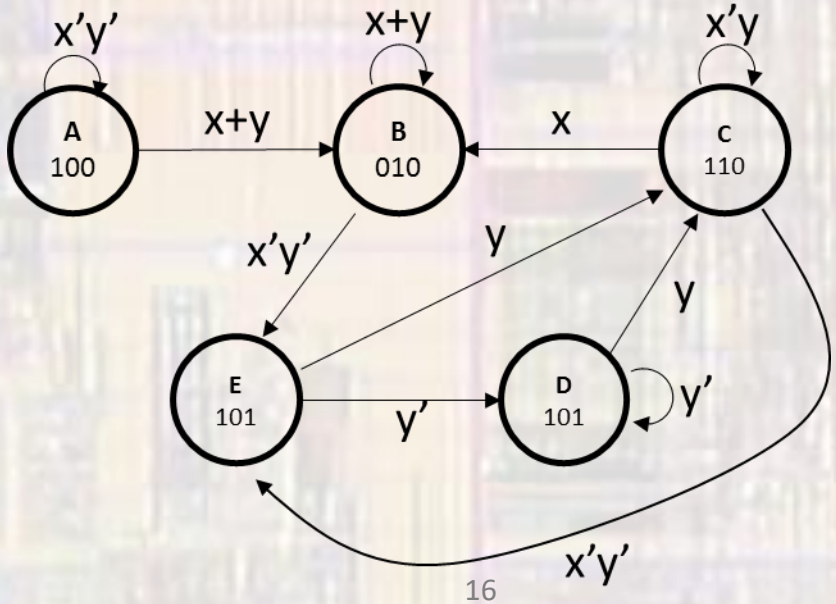
State Diagrams

- Redundant / Equivalent States
  - Example
    - 5 states
    - 2 inputs
    - 3 outputs



State Diagrams

- Redundant / Equivalent States
  - Example
    - States D and E
      - have the same output (101)
      - both go to C when y is true
      - both go to D when y' is true
    - Combine D and E



State Diagrams

- Redundant / Equivalent States
  - Example
    - 4 states
    - 2 inputs
    - 3 outputs