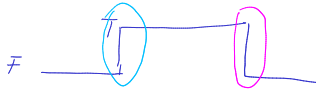


Embedded System Design and Modeling

IV. FSM Patterns

- ▶ **Design patterns:** reusable templates which appear often in applications
- ▶ Patterns
 - ▶ Operating on signal transitions
 - ▶ Debounce (one-sided, two-sided)

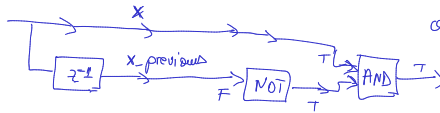
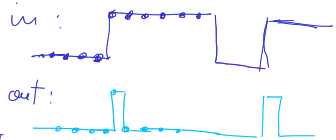
Operating on signal transitions



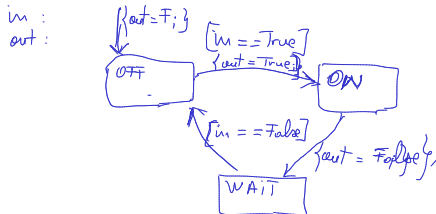
- ▶ For boolean signals/conditions
- ▶ Use when information is in the signals' **fronts** (edge / transition) rather than in its values
- ▶ Solution: detect signal transitions
 - ▶ rising edge
 - ▶ falling edge
 - ▶ both

Detect rising edge

► Draw here: detect rising edge

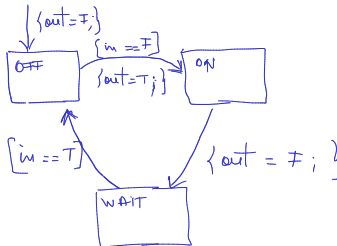
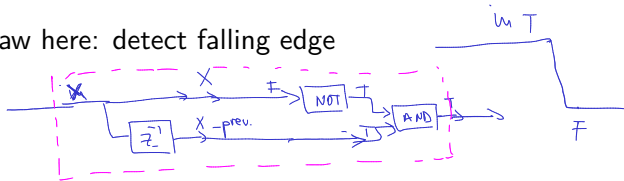


\Leftrightarrow



Detect falling edge

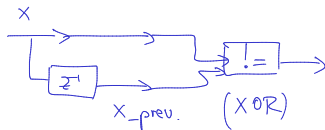
► Draw here: detect falling edge



Detect any edge



► Draw here: detect any edge



Debouncing

- ▶ For boolean signals/conditions
- ▶ Bouncing: real signals look like this:

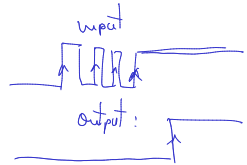
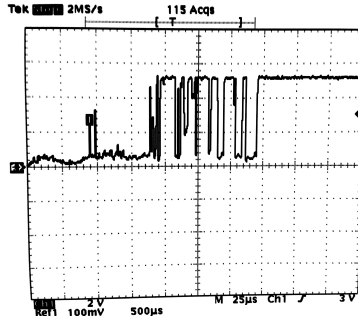


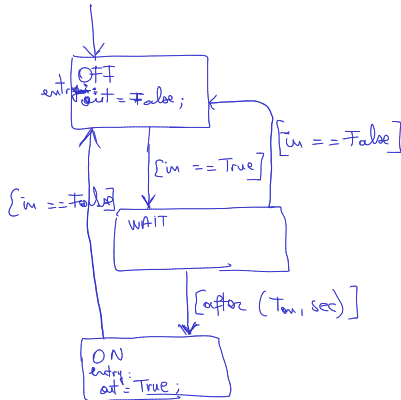
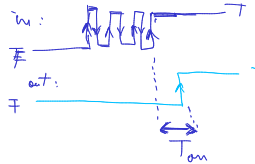
Figure 1: Signal change when pushing a button

- ▶ Use debouncing to avoid spurious transitions

Debouncing rising edge

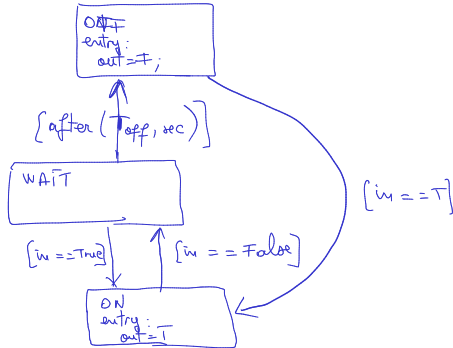
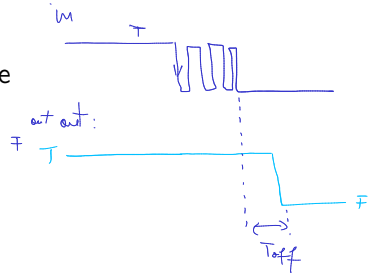
$in : \text{boolean}$
 $out : \text{boolean}$

► Draw here: debounce rising edge



Debouncing falling edge

- ▶ Draw here: debounce falling edge



Debouncing both edges

- ▶ Draw here: debounce both edges

