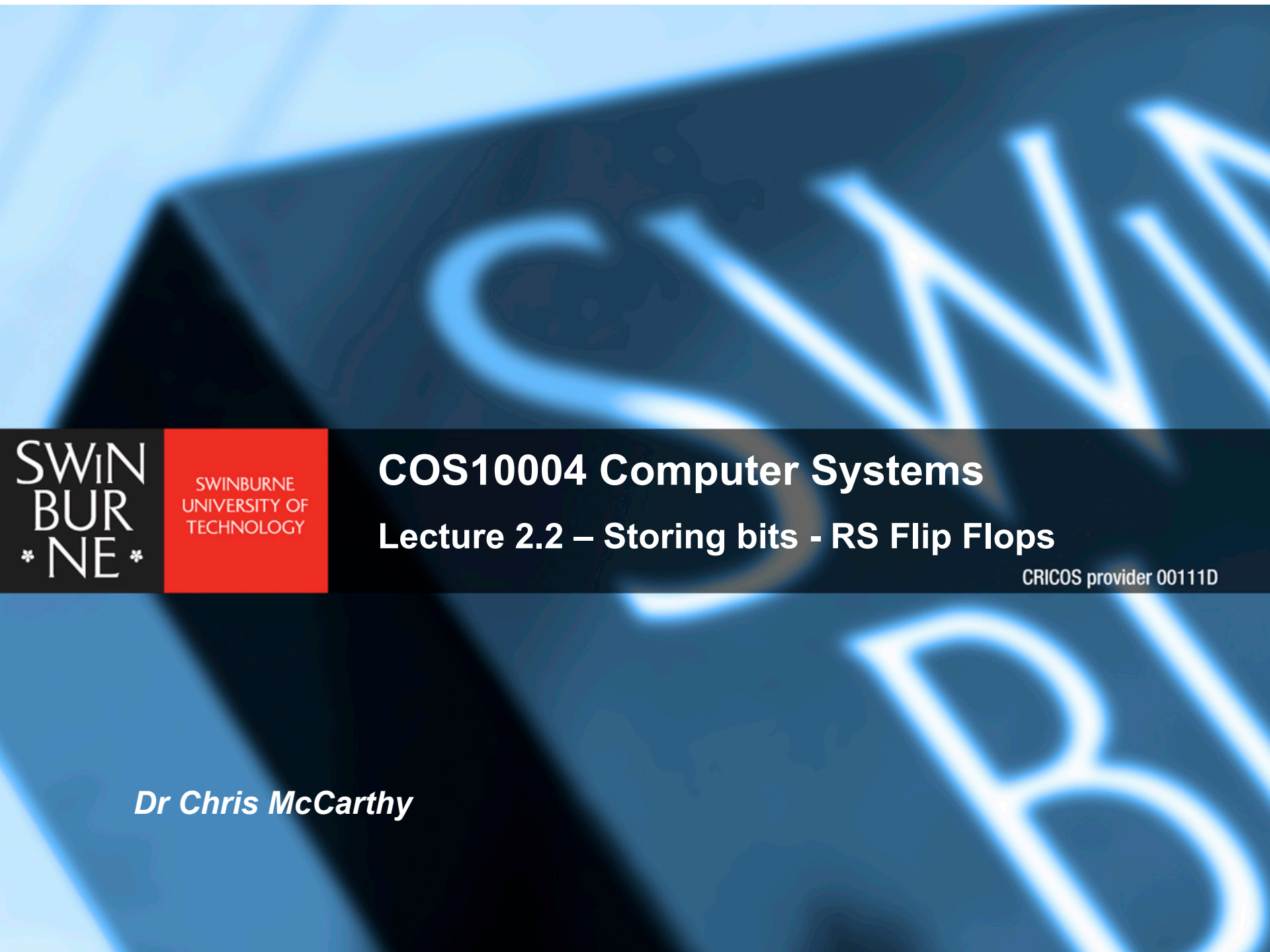


SWINBURNE UNIVERSITY OF TECHNOLOGY

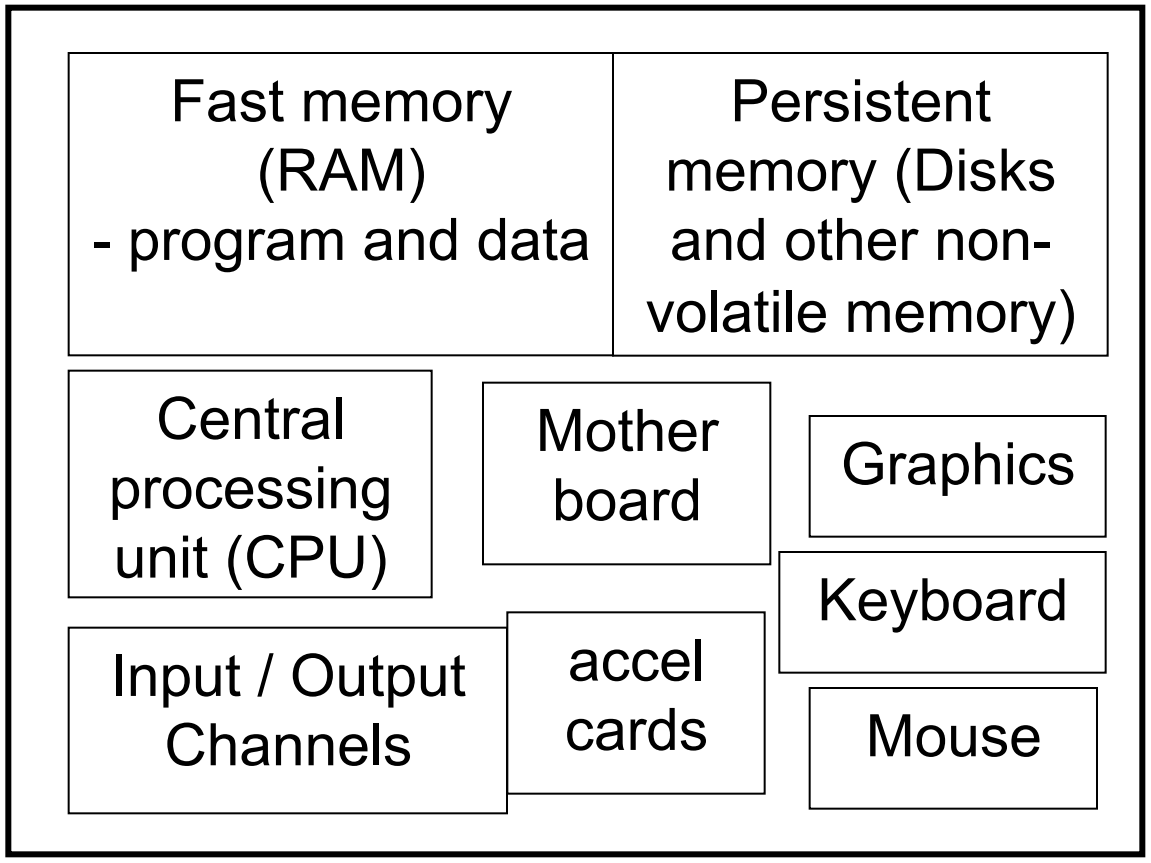
COS10004 Computer Systems

Lecture 2.2 – Storing bits - RS Flip Flops

CRICOS provider 00111D

Dr Chris McCarthy

What is a Computer System?

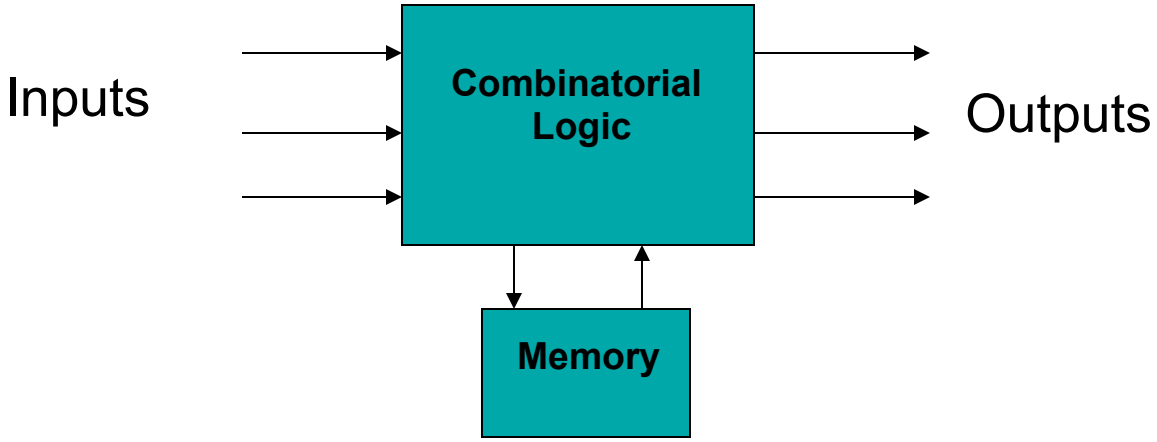


Hardware

What else?

BASICS OF ELECTRONIC STORAGE - CPU REGISTERS

- In a computer the output is determined by current inputs and memory (previous inputs) computed together.



CPU needs some way to remember information

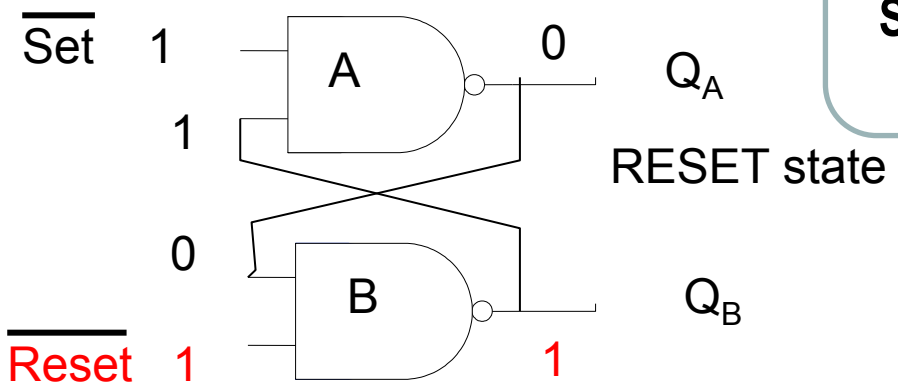
STORING 1 BIT

- Memory is built up of 1-bit storage units.
- We need a circuit that holds one bit.
- We set what it is to remember and it retains this until we actively change it (unless the power goes off!).
- The simplest is the ***RS Flip-Flop***

RS Flip-Flop - Operations

At start assume Q_A=0 (Q_B=1)

This is a stable state - a change in the Reset value from 1 to 0 will not change either output.



Here, "Set" means pull the Set pin to ground (0) to activate it (i.e, Q_A = 1)

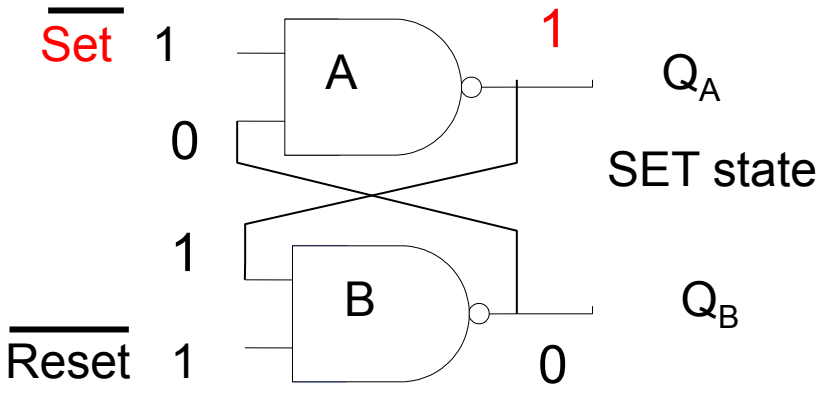
RS Flip-Flop - Operations

If Set is made low (0) for a moment, the output of A (Q_A) goes high (1).

This in turn makes its input to B high (1) turning the output of B (Q_B) to low (0).

Making Set high again will not cause a further change.

Making Set active (low) has set Q_A output high.



RS Flip-Flop - Operations

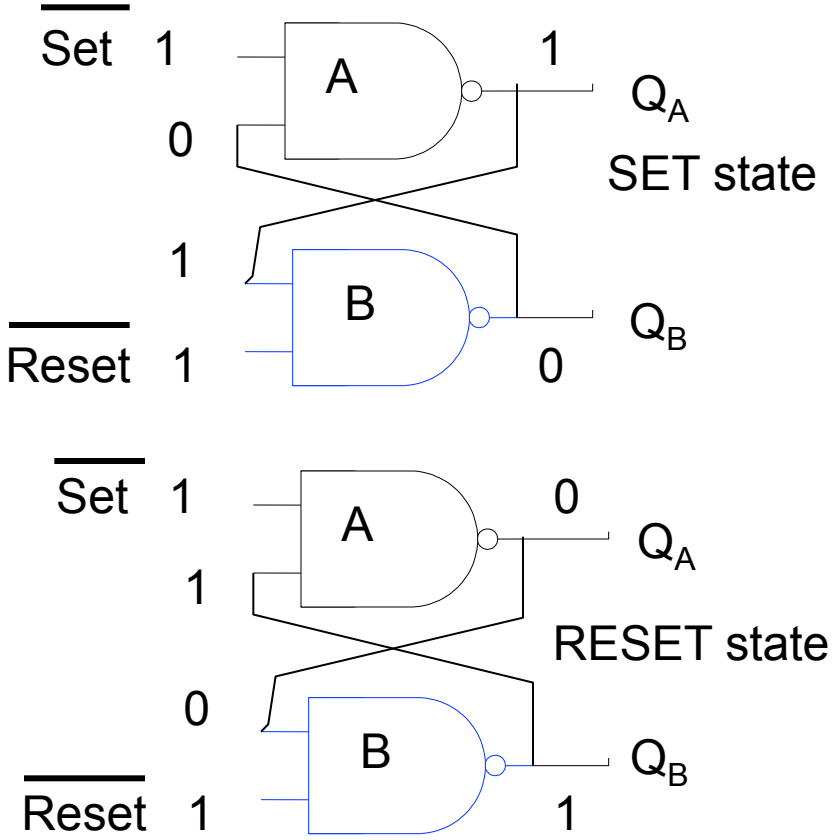
Confused?

It's a toggle switch using push-buttons.

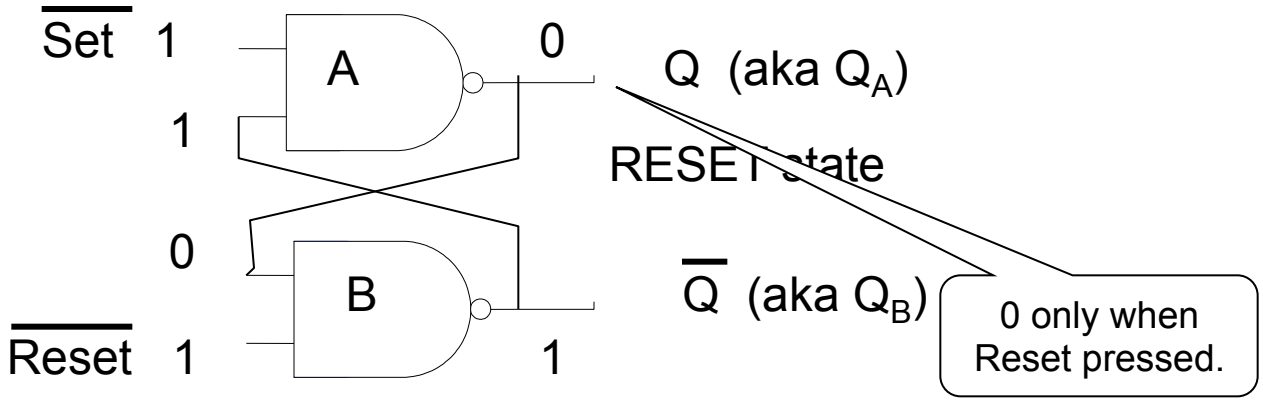
Pull Set low for a moment and Q_A turns on.

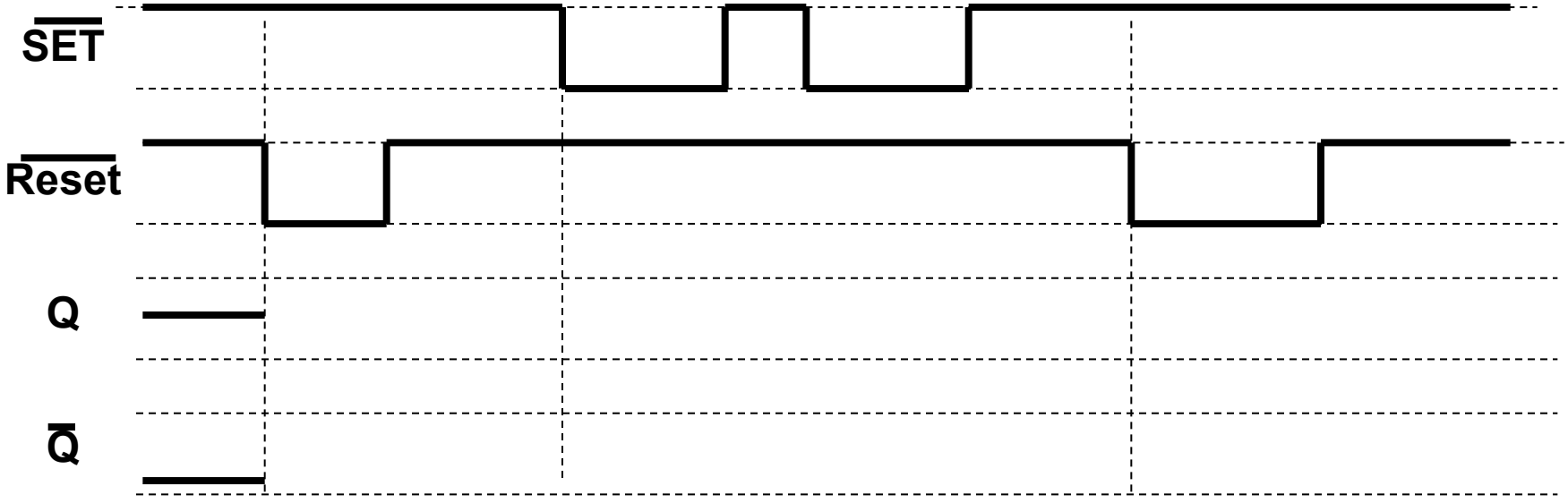
Pull Reset low for a moment and Q_B turns on.

Q_A and Q_B can never be on or off at the same time

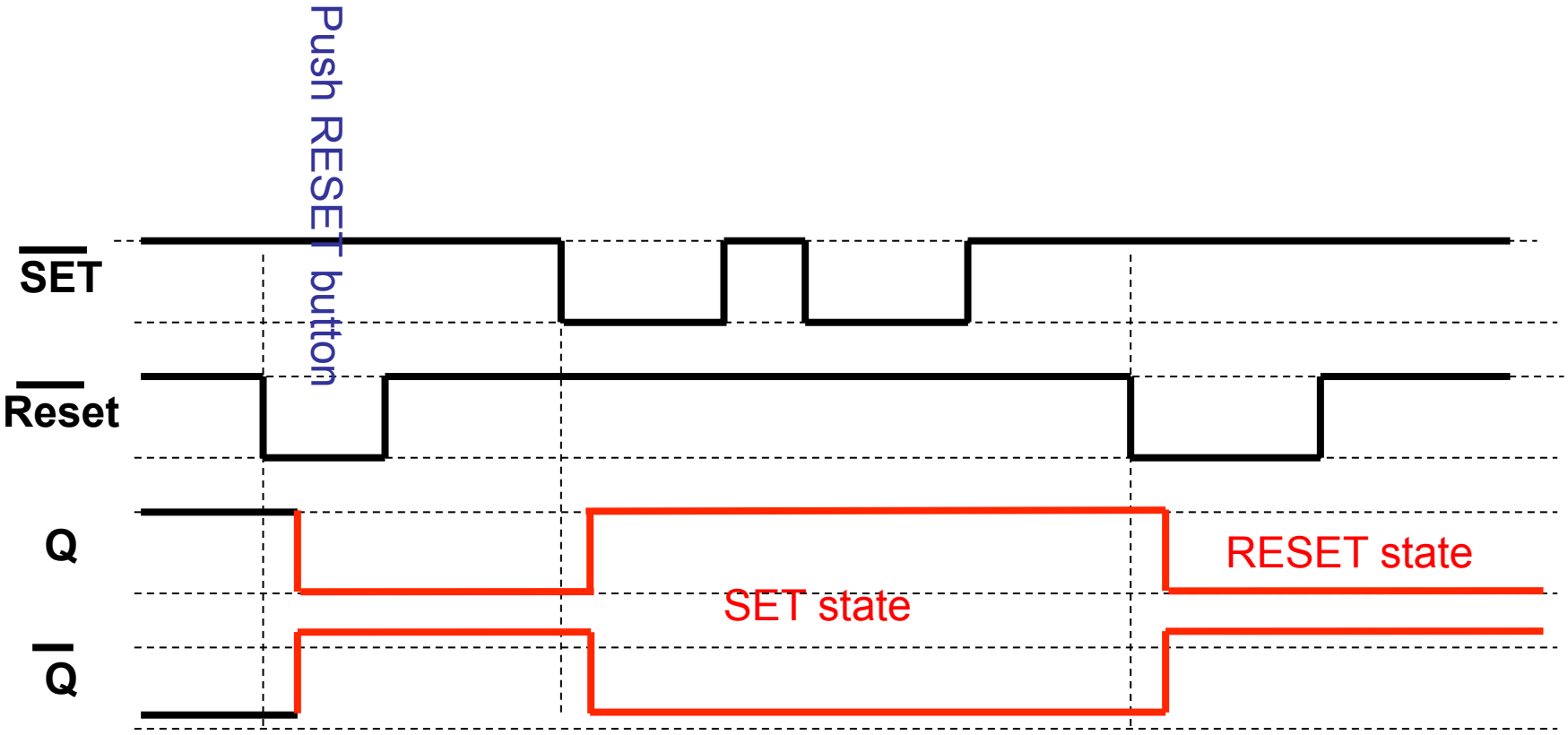


Exercise – complete the timing diagram below





Exercise – complete the timing diagram below



ACTIVE LOW INPUT RS FLIP-FLOP – TRUTH TABLE

$\overline{SET}$	$\overline{RESET}$	Q	$\overline{Q}$	
0	0	indeterminant		dangerous!!!
0	1	1	0	
1	0	0	1	
1	1	no change		

NB Both inputs must not be *active* (pulled low) at the same time

The flip flop outputs may change whenever an input changes. If we want synchronized changes we need to build more complex Flip-Flops!

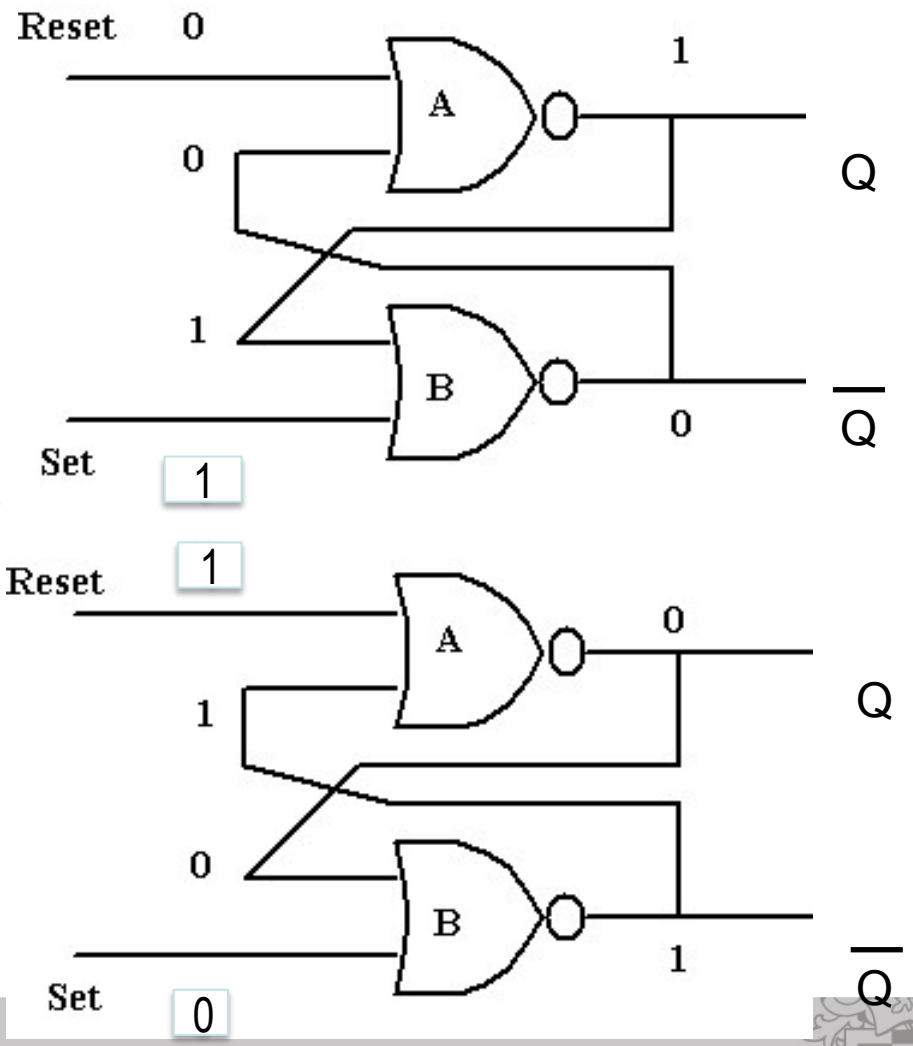
AN RS FLIP FLOP WITH ACTIVE HIGH INPUTS

An RS flip flop made out of cross coupled NOR gates has active high inputs.

The stable states are as shown.

Taking Set momentarily high will set Q.

Taking Reset momentarily high will set $\overline{Q}$ i.e. reset Q.



NOR-BASED (ACTIVE HIGH) INPUT RS FLIP-FLOP – TRUTH TABLE

SET	RESET	Q	$\overline{Q}$
0	0	no change	
0	1	1	0
1	0	0	1
1	1	indeterminate	

NB Both inputs must not be *active* at the same time

The flip flop outputs may change whenever an input changes. *If we want synchronized changes we need to build more complex Flip-Flops*

SUMMARY

- CPUs need storage to keep track of state and store computation outputs
- Flip Flops:
  - Store single bits of data
- RS Flip Flop:
  - Set / Reset
  - Asynchronous therefore problematic
- We can do better ! (next lecture we'll see!)