Sequential Circuits

Combination Logic

- Logic that performs some transformation operation on the inputs to produce outputs which are simple logic functions of the input.
- The outputs reflect a function of the current values on the inputs.

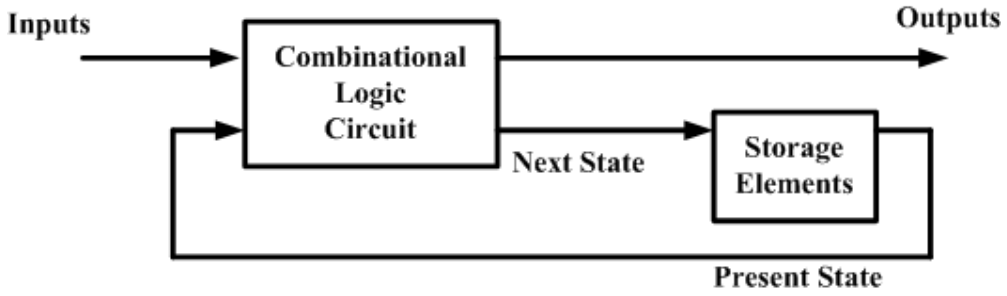
- There is not the capability to hold the value of the input.

Sequential Logic

- Logic elements capable of storing a logic value.
- Sequential circuits are those circuits that employ these elements.
- Will be looking at the methodologies for sequential circuit design.

Basic structure

- The basic structure of a synchronous sequential circuit is shown here.



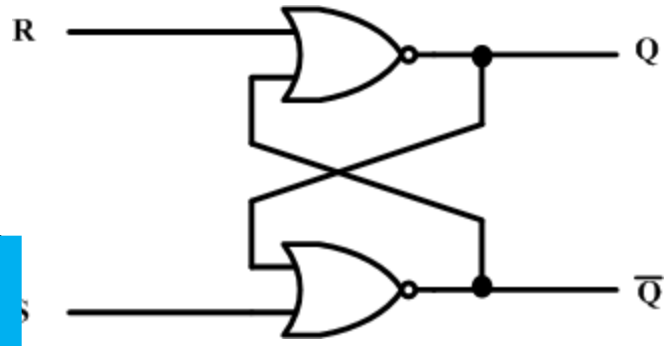
- Synchronous – One input is a clock and on the clock the next state becomes the present state of the system.
- Sequential – The circuit transitions between states in a regular manner.

Definitions

- Inputs – All the outside logic signal inputs to the circuit. Typically, the clock is not consider part of the signal inputs of the circuit.
- Outputs – The logic signal outputs.
- Present State – the logic value of all the state variables of the system. These are stored in the state memory.
- Next State – Given the present state and the current values on the inputs, the next state represents the next logic state the circuit will transition to on the next clock.

The SR Latch

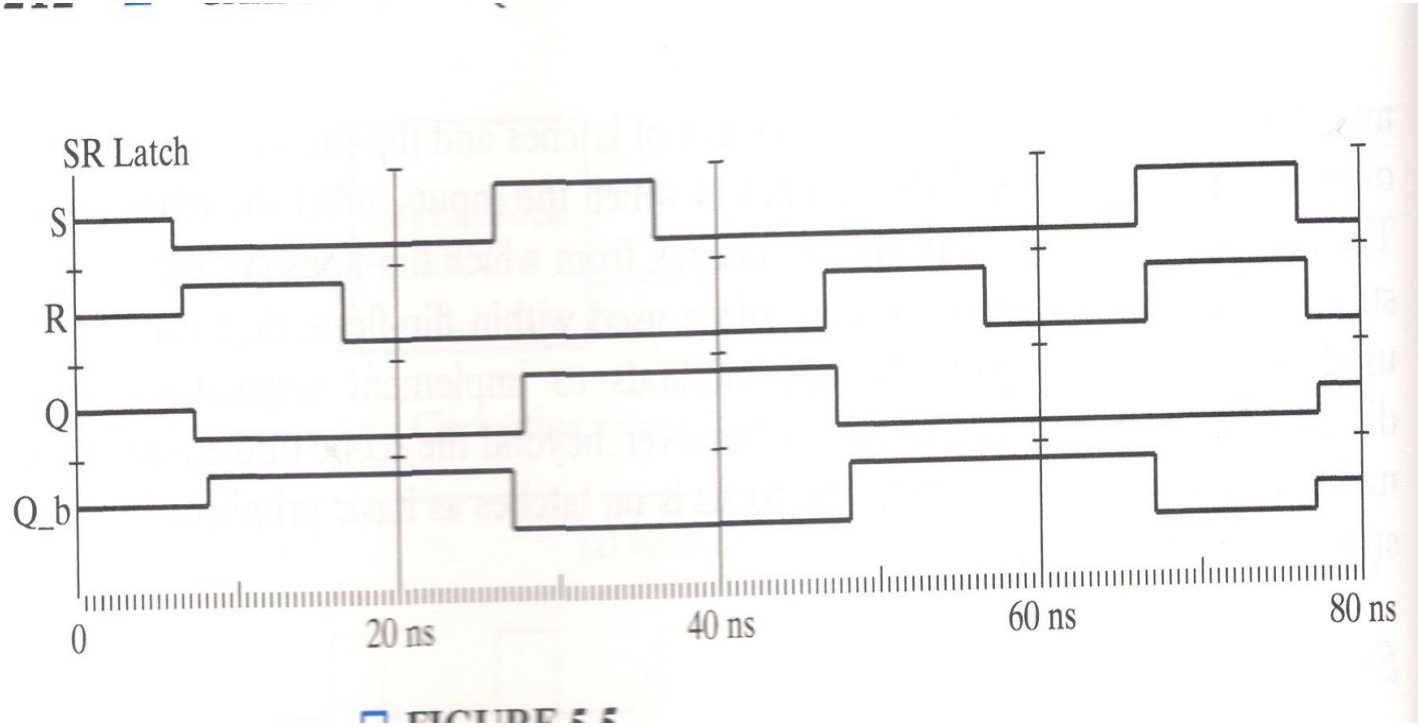
- The SR (Set-Reset) Latch



S	R	Q	Q′	
1	0	1	0	Set Q
0	0	1	0	Hold
0	1	0	1	Clear
0	0	0	1	Hold
1	1	0	0	Undefined

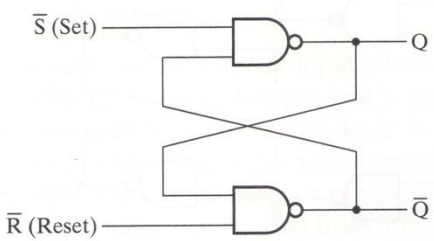
The waveform

- A simulation waveform would look something like this



Other implementations of the SR

- With NAND Gates

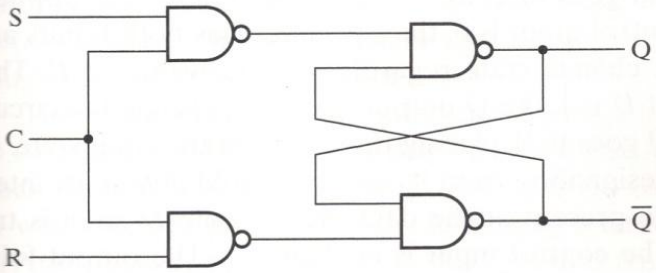


(a) Logic diagram

$\overline{S}$	$\overline{R}$	Q	$\overline{Q}$	
0	1	1	0	Set state
1	1	1	0	
1	0	0	1	Reset state
1	1	0	1	
0	0	1	1	Undefined

(b) Function table

- And adding a control input



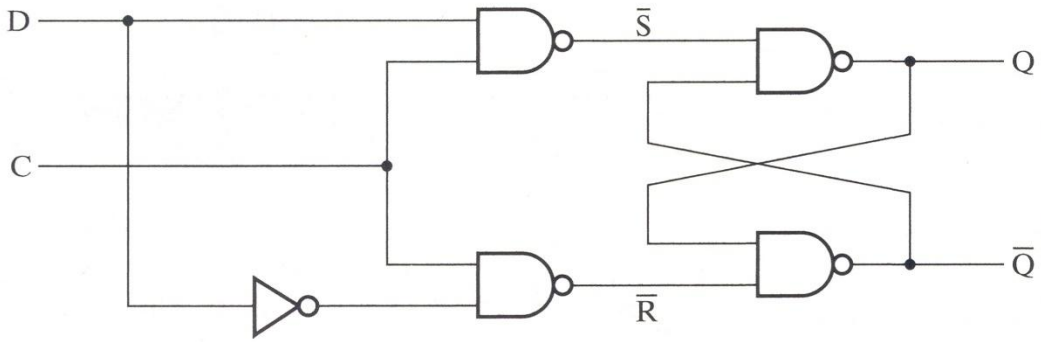
(a) Logic diagram

C	S	R	Next state of Q
0	X	X	No change
1	0	0	No change
1	0	1	Q = 0; Reset state
1	1	0	Q = 1; Set state
1	1	1	Undefined

(b) Function table

The D Latch

- The most common element in today's VLSI



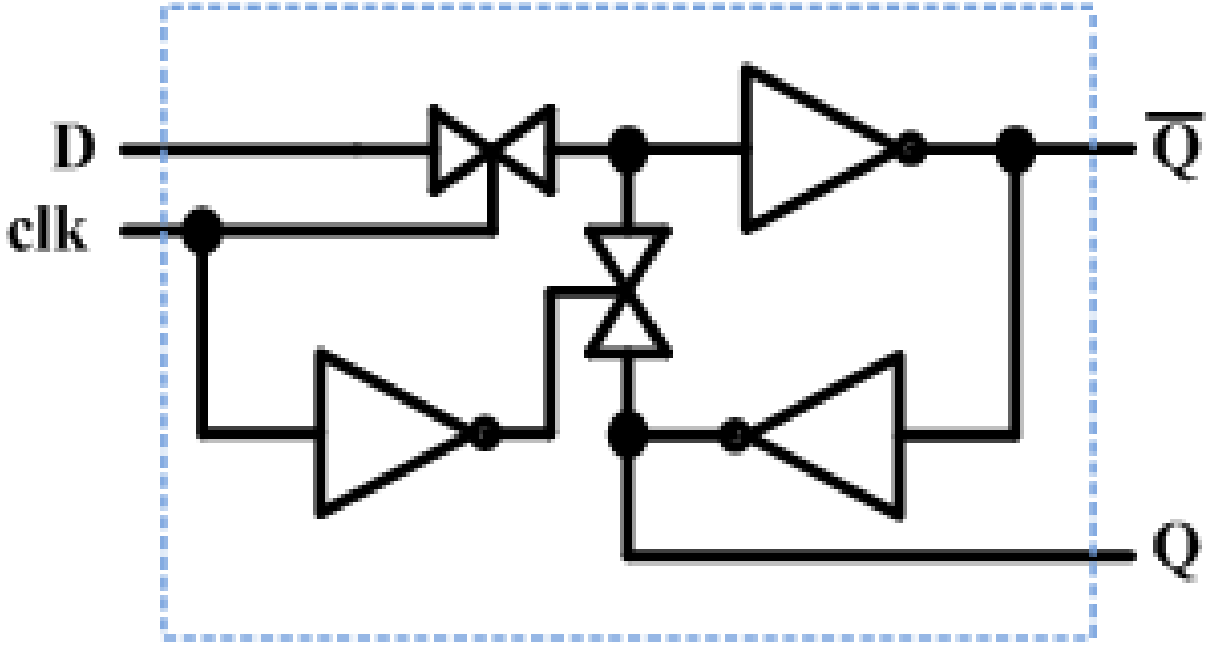
(a) Logic diagram

C	D	Next state of Q
0	X	No change
1	0	Q = 0; Reset state
1	1	Q = 1; Set state

(b) Function table

Another implementation

- The implementation used in VLSI used properties of the technology to reduce circuit elements and power consumption.



Contrast with the gate circuit

- The D latch circuit in the text would take 18 transistors in a VLSI circuit.
- This is contrasted to 8 or 10 transistors.

THANK YOU