Pulses, Clocks and Flip-Flops

Part 7e of
"Electronics and Telecommunications"
A Fairfield University E-Course
Powered by LearnLinc

Module: Digital Electronics
(in two parts)

- Text: "Digital Logic Tutorial ," Ken Bigelow, http://www.play-hookey.com/digital/
- References:
  - "Electronics Tutorial", part 10 (Thanks to Alex Pounds) http://doctord.dyndns.org:8000/courses/Topics/Electronics/Alex_Pounds/Index.htm
- Contents:
  - 7 – Digital Electronics 1
    - 5 on-line sessions plus one lab and a quiz
  - 8 – Digital Electronics 2
    - 5 on-line sessions plus one lab and a quiz
- Mastery Test part 4 follows this Module

Section 7: Digital Electronics 1

- Logic gates and Boolean algebra
- Truth Tables
- Binary numbers
- Memory
- Flip-Flops

Section 8: Digital Electronics 2

- Clocks and Counters
- Shift Registers
- Decoders
- Multiplexers & Demultiplexers
- Sampling

- **MT4**

Section 7 Schedule

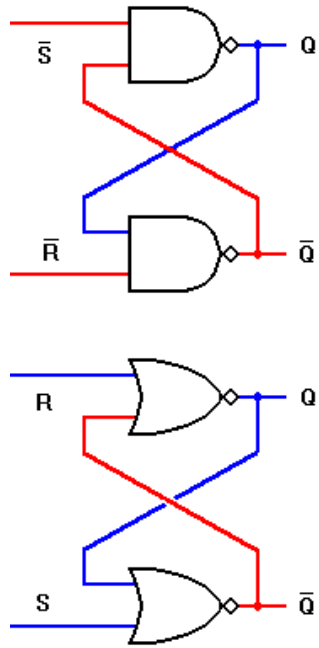
Session 7a	03/05	Introduction: Binary, Logic Gates and Boolean	Alex Pounds: Part 10 "Ken B": Home, Basic Gates, & Boolean Algebra
Session 7b	03/10	Logic Gates and Truth Tables	Alex Pounds: Part 10 "Ken B": Derived Gates, Xor
Session 7c	03/12	Binary numbers	"Keb B": Binary Addition "Vinay ": Binary Numbers
Session 7d	03/17	Memory: The Latch, Registers, RAM & ROM	"Ken B": RS Nand Latch, Clocked RS Latch, D Latch
Session 7e (Lab - 03/22, Sat.)	**03/19**	**Pulses, Clocks and Flip-Flops**	**"Ken B": RS Flip-Flop, JK Flip-Flop, D Flip-Flop, Flip-Flop Symbols**
Session 7f (Quiz 7 due 03/30)	03/24	Review for Quiz 7	
Session 7g	03/31	Quiz Results	

Review

- Binary: 1, 0; True, False; On, Off; High, Low; 5 volts, 0 volts
- Basic Logic Gates: AND, OR, NOT
- Derived Logic Gates: NAND, NOR, XOR
- Truth Tables: Enumerate outputs for all input combinations
- Boolean Algebra: Named Variables,Expressions, Equations, Rules
- Binary Numbers:
  - Based on powers of 2
  - k bits can count up to $2^k - 1$ (2^k values including zero)
    - 8-bits ⇨ 256 values, 16-bits ⇨ 65536 values (64k binary)
    - 10-bits ⇨ 1024 values (1k binary)
    - 20-bits ⇨ 1,048,576 values (1 meg binary)
    - Bits, Nibbles, Bytes, and Words
    - Negative Numbers: Two's complement
    - Binary Adders: half and full

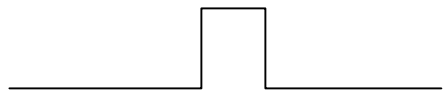
Review (continued)

- Storage
  - The RS Latch (a "bit" of storage)
    - Set = 1: Q=1
    - Reset = 1: Q=0
  - Register (n-bits of storage)
    - n latches (or flip-flops)
    - Stores a word (or byte) of data
  - RAM (addressable words of memory)
    - Read / write
    - Volatile (data lost if power lost)
  - ROMs, PROMs, EPROMs and EEROMS
    - Non-volatile memories

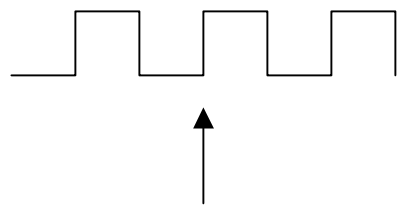


Pulses and Clocks

- Single Pulse
  - Signal normally low then high for a short time and goes back to low



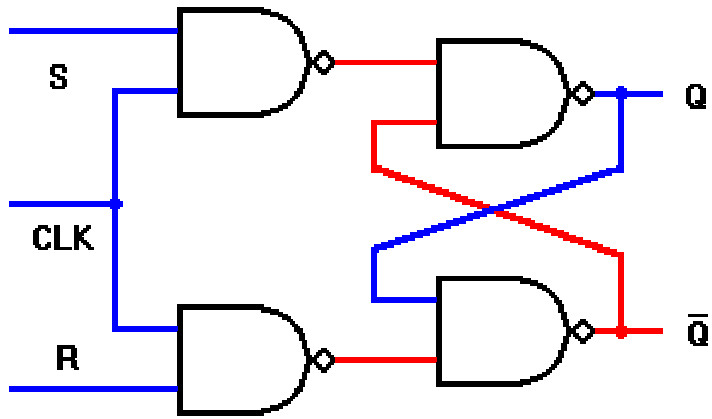
- Clock
  - Signal alternates high-low at a regular rate



Positive going edge

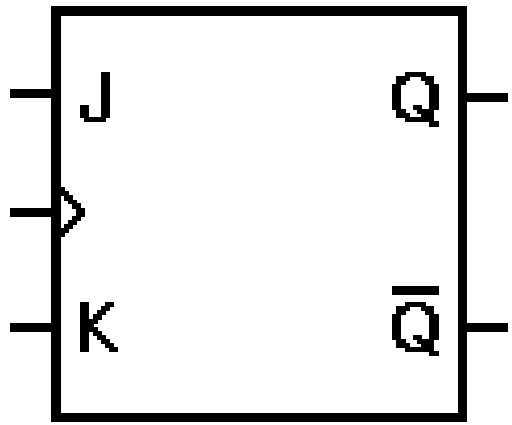
The Clocked RS LATCH

- Clock signal “enables Set and Reset pins
- Synchronous Logic
  - Slower than “ripple” logic
    - Gates have input to output “delay”
    - Delays build up as signals propagate through the logic
  - Predictable timing
    - Clocked (synchronous) logic prevents the build up of delays



The JK Flip-Flop

- Edge Triggered Generic Flip-Flop
  - the triangle symbol
    - triangle: rising edge triggers change
    - Not then triangle: falling edge triggers change
- Truth Table
  - J and K determines state change

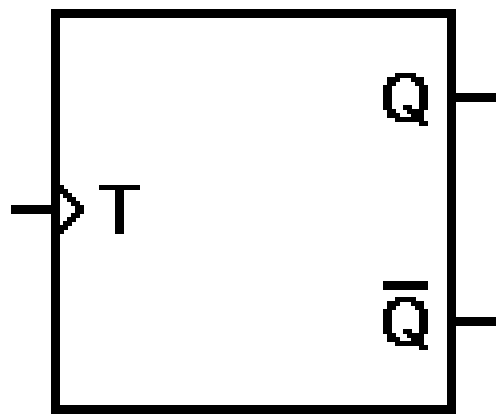


J	K	Q(t+1)
0	0	Q(t) – No change
0	1	0 – Reset
1	0	1 – Set
1	1	Q′(t) – Complement

The T Flip-Flop

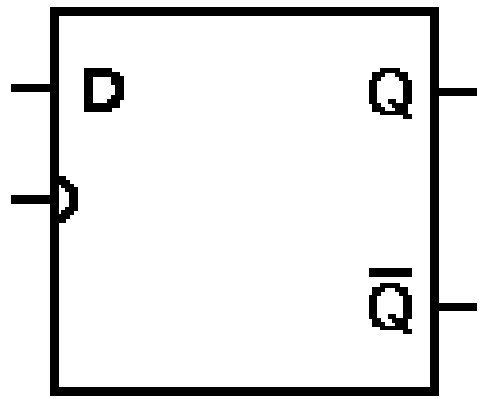
- State toggles (flips) on each positive going clock edge

T	Q(t+1)
0	Q(t) – No change
1	Q′(t) - Complement



The D Flip-Flop

- Simple triggered storage Flip-Flop



D	Q(t+1)
0	0 - Reset
1	1 - Set

Simulation

- We'll again go to www.play-hookey.com/digital to see Latches in action

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