Memory: The Latch, Registers, RAM & ROM

Part 7d 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

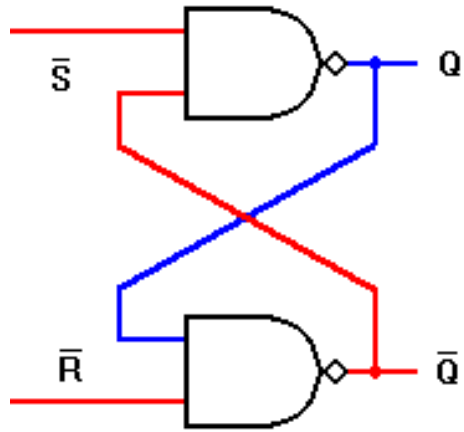
Session 7a	03/05	Introduction: Binary, Logic Gates and Boolean	Alex Pounds: Part 10 "Ken B": Home, Basic Gates, & Boolean Algebra
Session 7b	03/10	Logic Gates and Truth Tables	Alex Pounds: Part 10 "Ken B": Derived Gates, Xor
Session 7c	03/12	Binary numbers	"Keb B": Binary Addition "Vinay ": Binary Numbers
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	

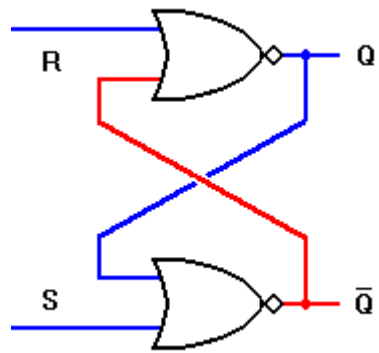
Review

- 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

The RS Latch

- Two NAND (or NOR) gates;
  - One bit of Storage
- Two stable states
  - If on gate is on; the other must be off
- Bringing S′ low (or S high) turns the top gate on
  - the "SET" state; Q = 1, Q′ = 0
- Bringing R′ low (or R high) turns the bottom gate on;
  - the "RESET" state; Q = 0, Q′ = 1





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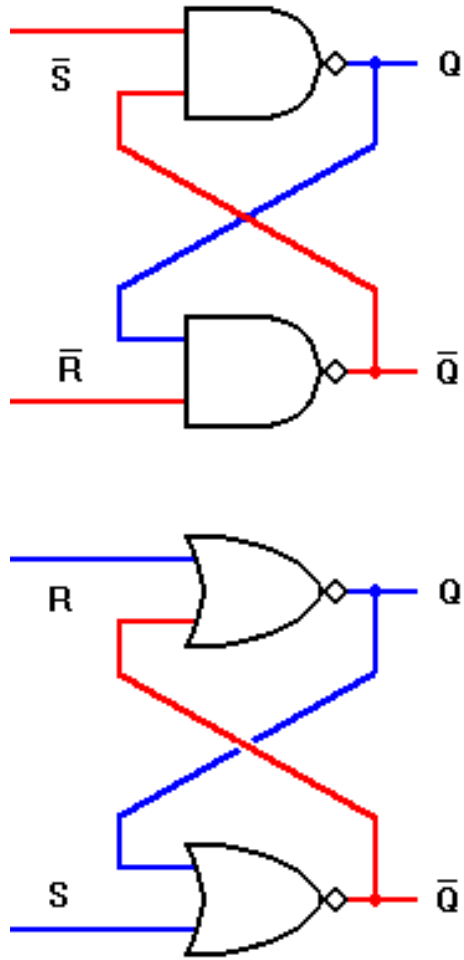


Simulation

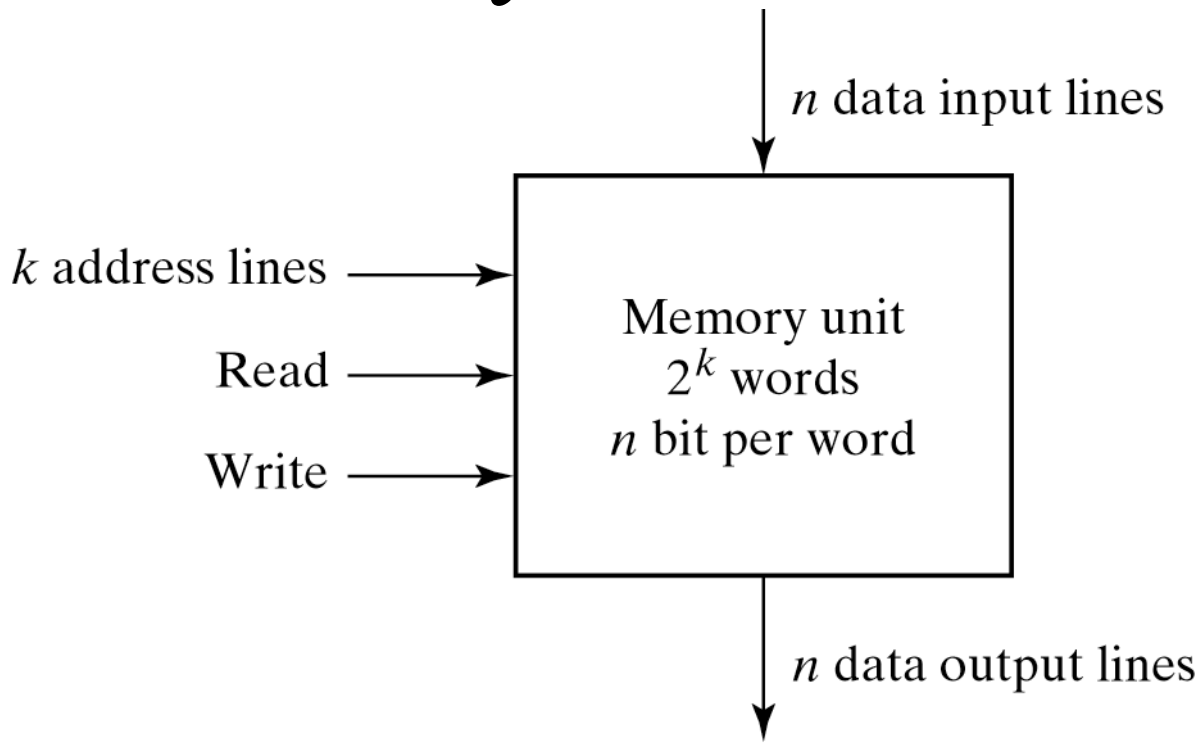
- We'll again go to www.play-hookey.com/digital to see Latches in action

Parallel Register

- Use k latches to store a k-bit word
- Stores a k-bit binary number
  - 0 to $(2^k - 1)$: an "unsigned integer" or
  - $-[2^{(k-1)} - 1]$ to $[2^{(k-1)} - 1]$: a "signed" integer or
  - A k-bit "Floating Point" number (not yet covered)

RAM Memory Unit

- "Address"
  Selects a word
- "Write"
  Sets or resets bits
- "Read"
  "strobes" the selected word into an output register



Read-Only Memory (ROM)

- Same as RAM, but simpler
- Data is established when manufactured and cannot be altered

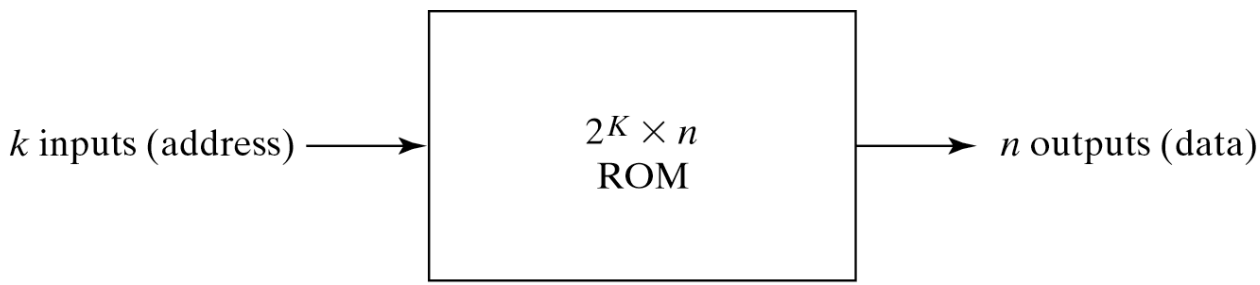


Fig. 7-9 ROM Block Diagram

Other Semiconductor Memories

- PROM: Data "burned" in after manufacture
- EPROM: PROMS that are "erasable"
  (usually by exposure to UV light)
  (note that x-rays can also change them as in airport security)
- Flash or EEROM: Electrically erasable. Can be fully erased and rewritten in place using higher voltages than used to read data.

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