

# Overview of Digital Circuits

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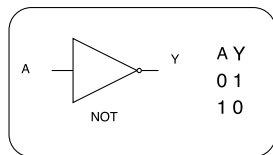
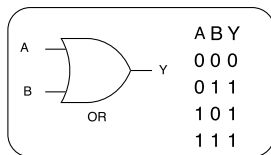
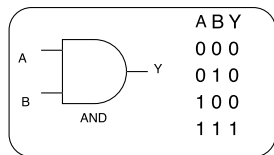
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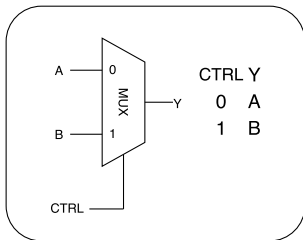
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# Combinatorial Circuits/Logic Gates



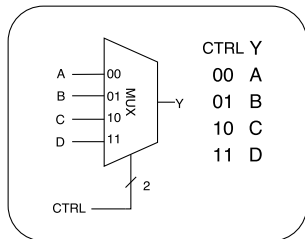
- **AND**, logic product
- **OR**, logic sum
- **NOT**, logic negation

# Combinatorial Circuits/Multiplexer 2-to-1



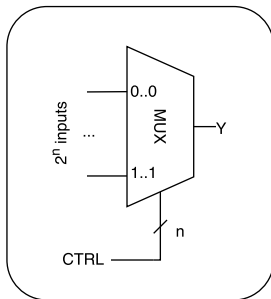
- It acts as a **controlled digital switch**
- When the **CTRL** input is **0**, **input A** is connected with **output Y**
- When the **CTRL** input is **1**, **input B** is connected with **output Y**

# Combinatorial Circuits/Multiplexer 4-to-1



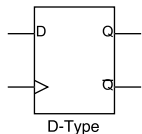
- It has **4 data inputs**
- **CTRL** input is 2-bit
- When the **CTRL** input is **00**, **input A** is connected with **output Y**
- When the **CTRL** input is **01**, **input B** is connected with **output Y**
- When the **CTRL** input is **10**, **input C** is connected with **output Y**
- When the **CTRL** input is **11**, **input D** is connected with **output Y**

# Combinatorial Circuits/Multiplexer $2^n$ -to-1

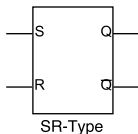


- It has  $2^n$  **data inputs**
- **CTRL** input is n-bit
- The **CTRL** input selects one of the  $2^n$  **data input** to be connected with **output Y**

# Sequential Circuits/Flip-Flops



D-Type

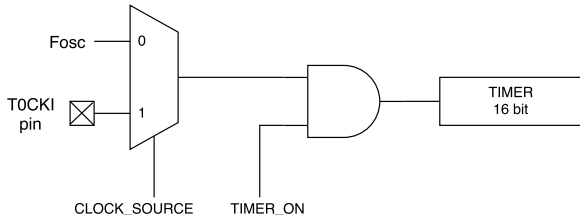


SR-Type

| $CK$       | $D$ | $Q$  | $\overline{Q}$ |  | $S$ | $R$ | $Q$  | $\overline{Q}$  |
|------------|-----|------|----------------|--|-----|-----|------|-----------------|
| $\uparrow$ | 0   | 0    | 1              |  | 0   | 0   | $Q'$ | $\overline{Q'}$ |
| $\uparrow$ | 1   | 1    | 0              |  | 1   | 0   | 1    | 0               |
| X          | X   | $Q'$ | $\overline{Q}$ |  | 0   | 1   | 0    | 1               |
|            |     |      |                |  | 1   | 1   | ?    | ?               |

- **D-Type:** the input  $D$  is copied to output  $Q$  when a *low-to-high* transition occurs in the  $CLOCK$  input
- **SR-Type:** inputs  $S$  and  $R$  perform **set** and **reset** operations on  $Q$  output

# An example: a timer



- A **timer** is a variable/register that is incremented on the basis of a periodic signal, that is the **source** of the timer
- When `CLOCK_SOURCE = 0`, the **Fosc** (system CPU clock) is selected as source
- When `CLOCK_SOURCE = 1`, the **external input pin** is selected as source
- When `TIMER_ON = 0`, the AND gate **blocks** clock source, the timer is not incremented
- When `TIMER_ON = 1`, the clock source goes to the timer that is incremented

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