NOT GATE

(INVERTER GATE)

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ABSTRACT

In digital logic, an inverter or NOT gate is a logic gate which implements logical negation. The truth table is shown on the right.

Input	Output
X	Z
0	1
1	0

An inverter circuit outputs a voltage representing the opposite logic-level to its input. Its main function is to invert the input signal applied. If the applied input is low then the output becomes high and vice versa. Inverters can be constructed using a single NMOS transistor or a single PMOS transistor coupled with a resistor. Since this 'resistive-drain' approach uses only a single type of transistor, it can be fabricated at low cost. However, because current flows through the resistor in one of the two states, the resistive-drain configuration is disadvantaged for power consumption and processing speed. Alternatively, inverters can be constructed using two complementary transistors in a CMOS configuration. This configuration greatly reduces power consumption since one of the transistors is always off in both logic states. Processing speed can also be

improved due to the relatively low resistance compared to the NMOS-only or PMOS-only type devices. Inverters can also be constructed with bipolar junction transistors (BJT) in either a resistor–transistor logic (RTL) or a transistor–transistor logic (TTL) configuration.

Digital electronics circuits operate at fixed voltage levels corresponding to a logical 0 or 1 (see binary). An inverter circuit serves as the basic logic gate to swap between those two voltage levels. Implementation determines the actual voltage, but common levels include (0, +5V) for TTL circuits.

INTRODUCTION

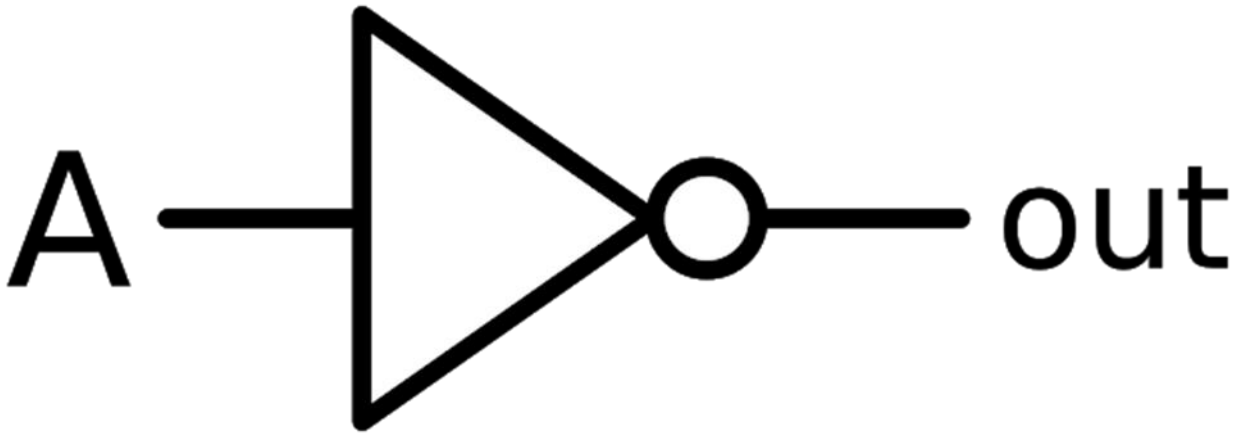
Logic gates are the basic building blocks of digital logic circuits as well as digital electronics. A gate is defined as a logic device which computes functionally on a 2 valued input signal. Logic gates are of many types such as OR, AND, NOR, NAND, EX –OR and NOT etc. Among these, all gates have two inputs and one output except NOT gate. NOT gate has only one input and one output. This gate produces the reverse output of applied input. So this gate is also called as 'Digital Inverter'.

NOT Gate Logic Symbol and Boolean Expression

We know the NOT gate is an inverter, which inverts or reverses the input.. So the output is represented by '-' bar symbol of the input. The Boolean expression of the NOT gate is $Z = \bar{X}$. Pronounced as "Z is equal to X bar". The logic symbol of the NOT gate is shown in below figure.

If X is the input and Z is the output, then if X = 0, then Z = 1

If X = 1, then Z = 0.



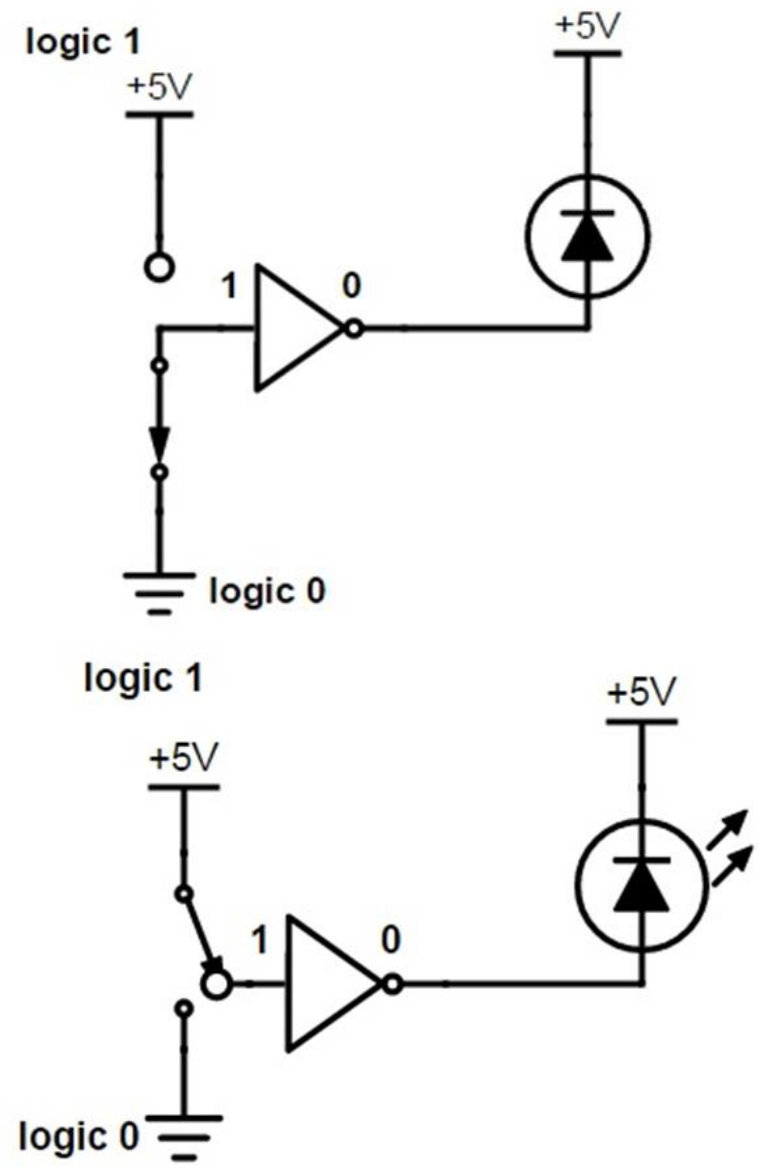
The bubble at the output port represents the inverting operation. That means for high logic signal input, the output of the NOT gate will be LOW, similarly for low logic signal input the output of NOT gate will be HIGH. We can easily understand this by truth table stated below.

Input	Output
X	Z
0	1
1	0

THEORY

Explanation of Not gate with light switch circuit

The NOT gate can be easily understood by using a LED (light emitted Diode) circuit. This is also called Light switch circuit. In this circuit, NOT gate functions like an electronic switch. When it got high input, the LED connected at the output will be OFF, as the output of NOT gate becomes 0. In the same way, when the logic gate is connected with LOW input, the LED will be ON, as the output becomes 1. The Light switching circuit with NOT gate is shown below.

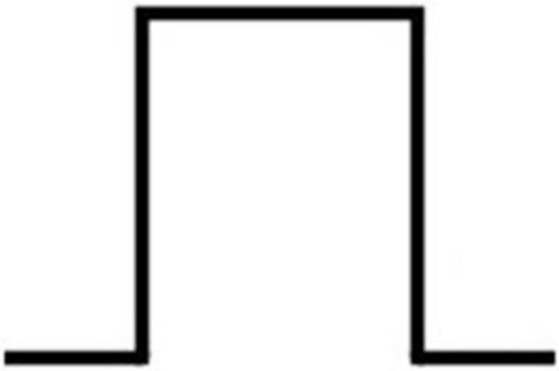


Here we connect an alterable switch with the NOT gate and the output of NOT gate is connected to a LED. An LED is an electronic device which will ON and off when it receives high voltage and low voltage respectively. When the switch is connected to +5 V, the switch is on position so the LED emits light. When the NOT gate is connected to Ground, the LED will OFF so it doesn't emit any light.

Pulsed Operation

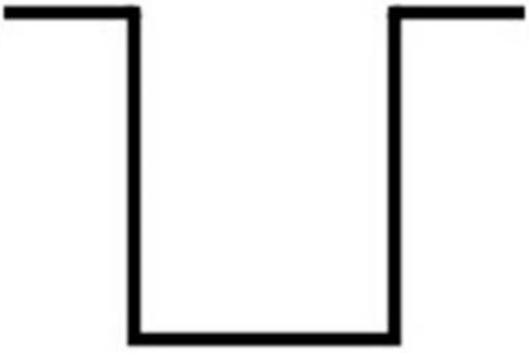
When we apply a pulse signal to the NOT gate, it will ON and OFF for HIGH and LOW levels respectively. This means,

for every high level clock pulse



Input (X) = 1 Output (Z) = 0

for every low level clock pulse



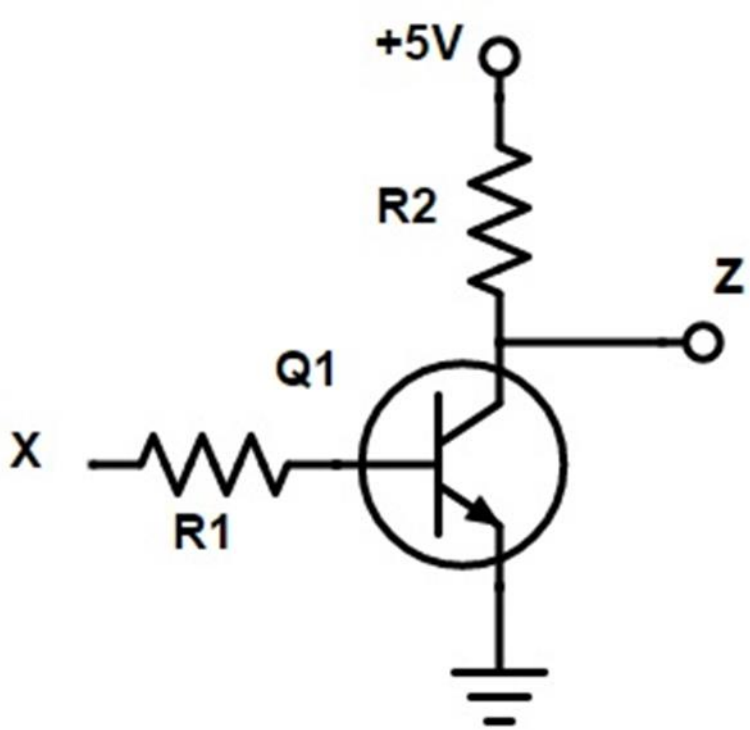
Input (X) = 0 Output (Z) = 1

Not Gate using NPN Transistor

We can design a NOT gate by using a NPN transistor as shown in below picture. The Base (B) of the NPN transistor is connected with the input signal X. we connect a supply voltage of +5 V to the emitter (E) and the output Z is collected at the emitter. When the low level voltage 0 V is connected to the input, then the transistor will be OFF. So no current flows through it. This means the supply voltage +5 V will be measured at the output port, which is considered as HIGH state

Similarly, when the high level voltage +5 V is connected to the input, then the transistor will be ON. So the total supply current will be drawn by transistor. This means the no voltage is measured at the output port, which is considered as LOW state.

At this situation the output voltage is measured as +5 V, which will be considered as HIGH logic level. The transistor designed NOT gate is shown below.



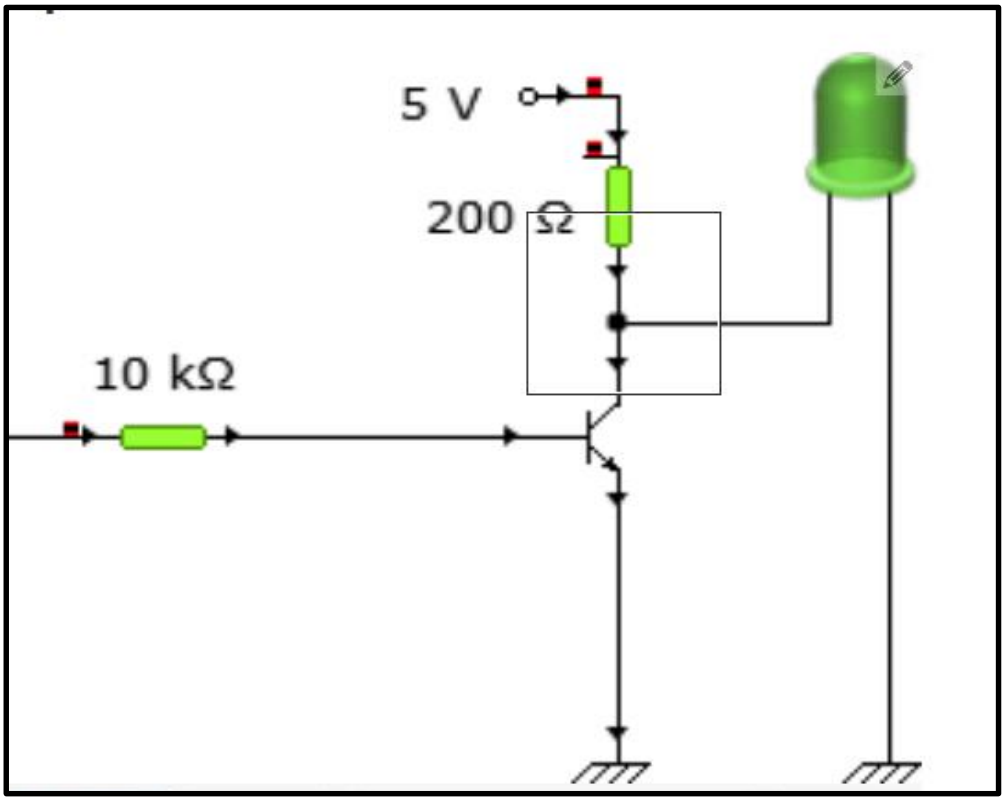
IMPLEMENTATION

Objective – To implement the logic NOT gate using NPN transistor

Components Required –

1. A breadboard
2. A bunch of 5k and 10k resistors
3. A LED
4. Any NPN type transistors (for example 2N3904, BC547, BC548, BC549 etc.)
5. Supply source
6. Voltage regulation IC 7805 if you are using 9 volt battery source.
7. Switches

Circuit Details:-



Concept about NOT GATE :-

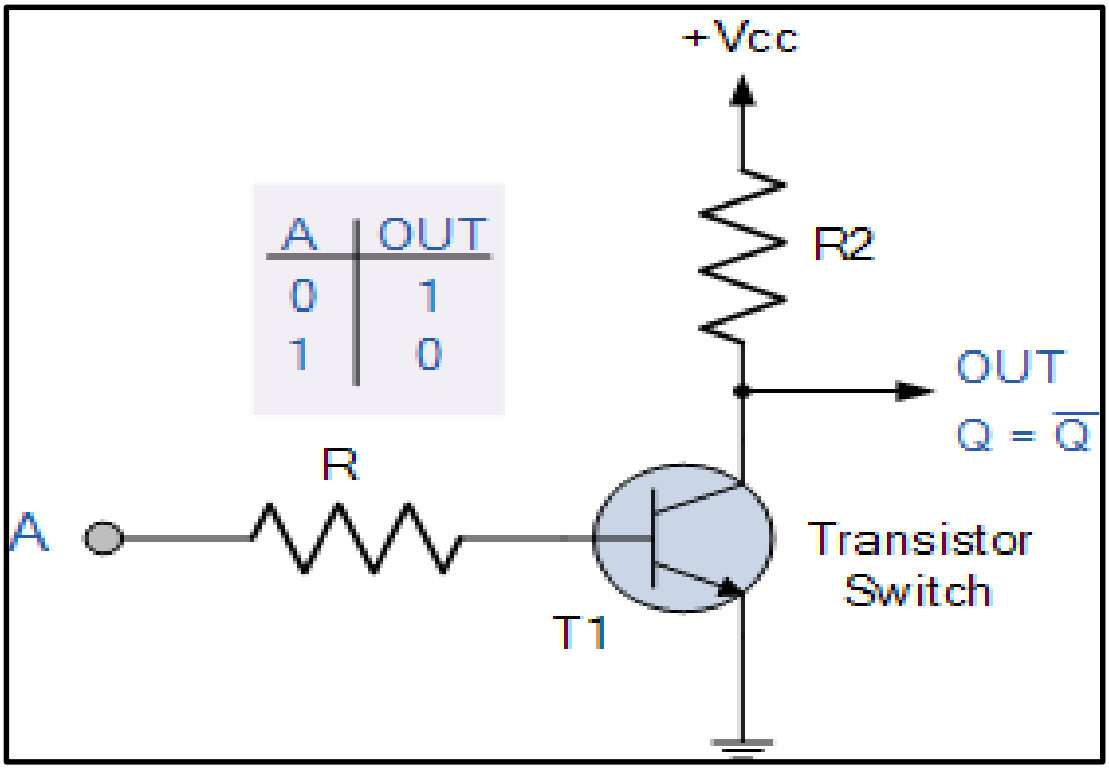
It is a single input device which has an output level that is normally at logic level “1” and goes “LOW” to a logic level “0” when its single input is at logic level “1”, in other words it “inverts” (complements) its input signal. The output from a NOT gate only returns “HIGH” again when its input is at logic level “0” giving us the Boolean expression of: $A = Q$.

Then we can define the operation of a single input digital logic NOT gate as being:

“If A is NOT true, then Q is true”

TRANSISTOR NOT GATE –

A simple 2-input logic NOT gate can be constructed using a RTL Resistor-transistor switches as shown below with the input connected directly to the transistor base. The transistor must be saturated “ON” for an inverted output “OFF” at Q.



Logic NOT Gates are available using digital circuits to produce the desired logical function. The standard NOT gate is given a symbol whose shape is of a triangle pointing to the right with a circle at its end. This circle is known as an “inversion bubble” and is used in NOT, NAND and NOR symbols at their output to represent the logical operation of the NOT function. This bubble denotes a signal inversion (complementation) of the signal and can be present on either or both the output and/or the input terminals.

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