

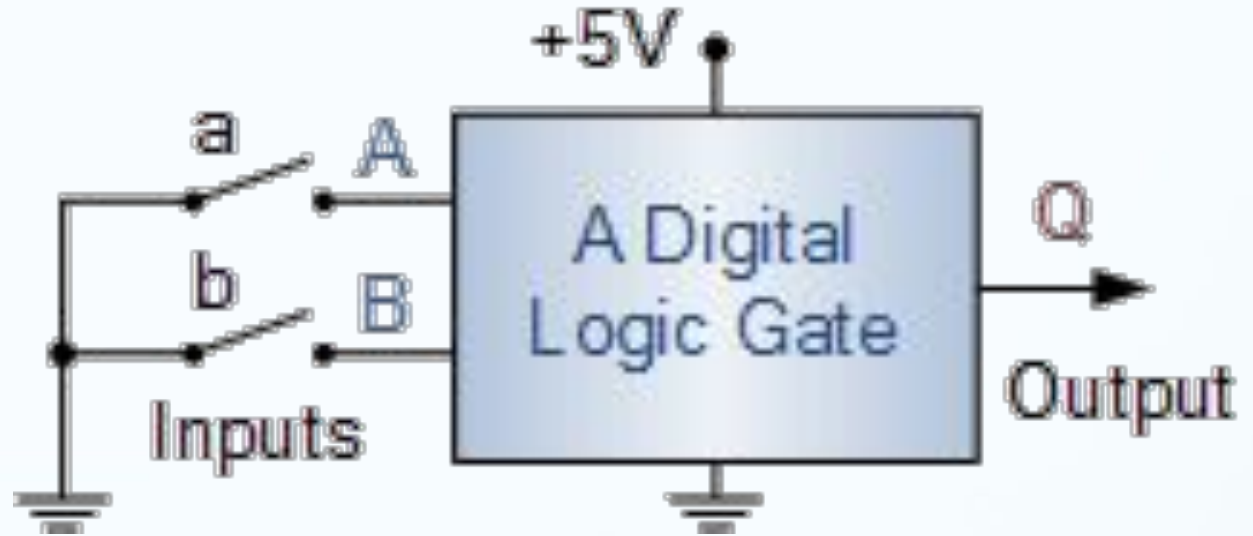
CS 2461: Lab 3
Pull-up (Pull-down) resistors
Building combinational logic circuits

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Designing Circuit to switch between 0 and 1

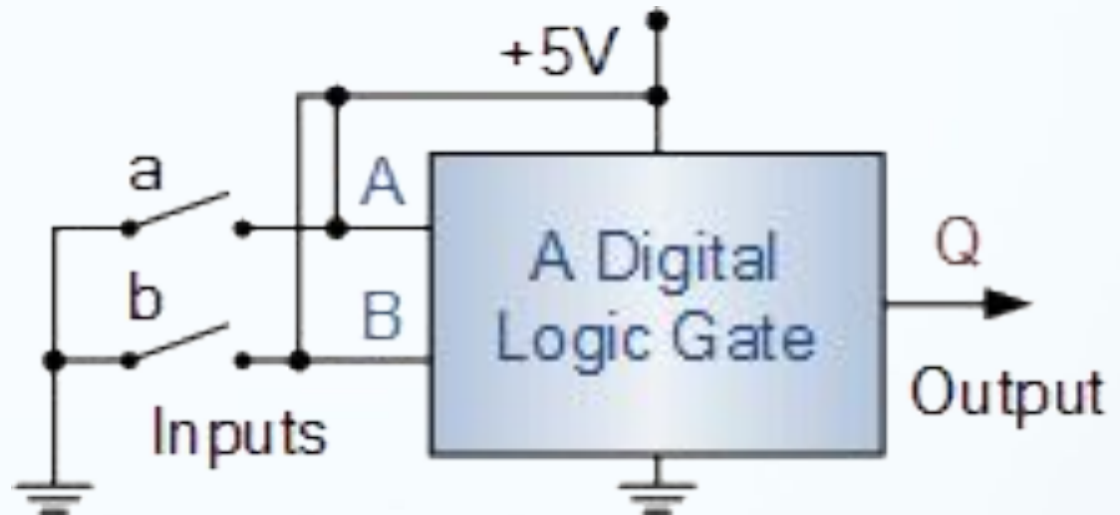
- Recall- inputs to binary are 0 or 1...
- How to set binary variables to 0 or 1 in your hardware circuits ?
- Use a switch...each switch can be viewed as a binary variable (values are 0 or 1)
- We want to close switch and set input $A=0$
- We want to open switch and set input $A=1$

Question



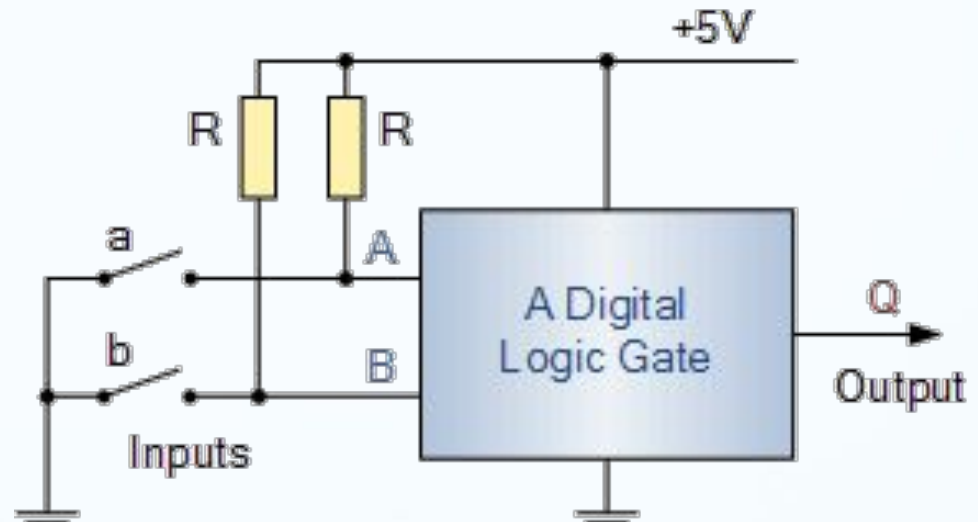
- The switches a and b represent two inputs to the device
- If switch a is 'closed' (on) then:
 - A is connected to ground and $A=0$
- IF switch b is closed then:
 - B connected to ground and $B=0$
- Question: What is value of A when switch a is open ?
- Do you see a problem ?

Solution ?



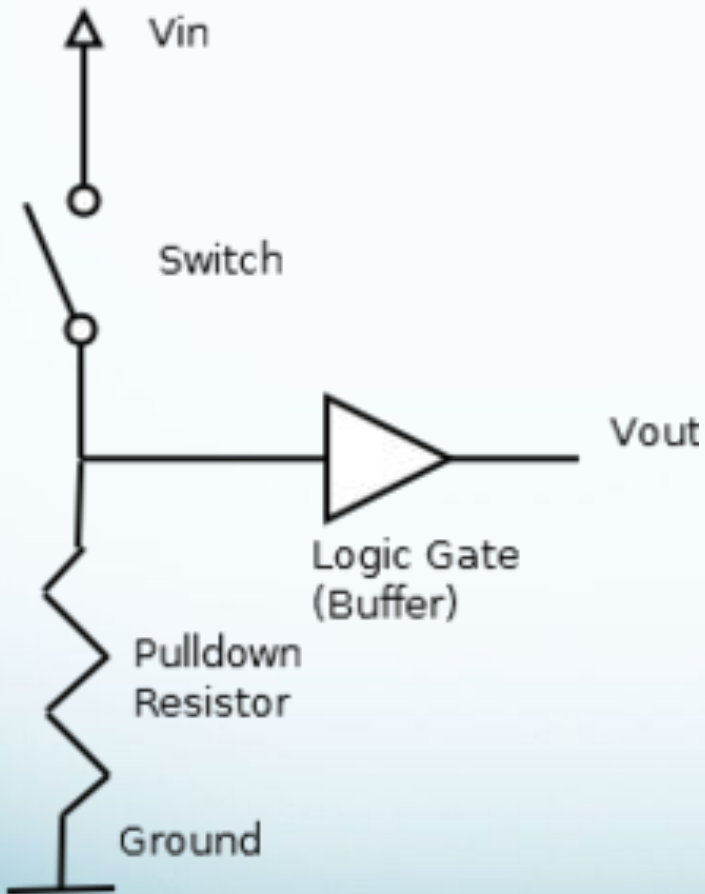
- Open to set $A=1$
- Close to set $A=0$
- Will this work ?

Solution

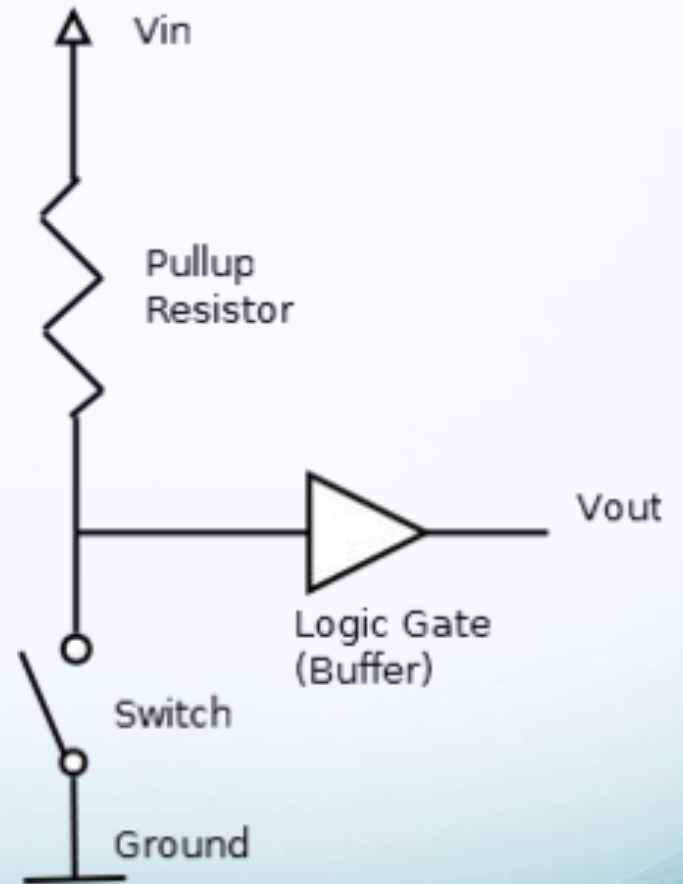


- The switches a and b represent two inputs to the device
- If switch a is 'closed' (on) then:
 - A is connected to ground and $A=0$
- IF switch a is open path to +5V:
 - A connected to +5V and $A=1$
- This resistor is called a pull-up resistor
 - When switch is open it pulls up value to 1

Pull-Down



Pull-Up



Pull-up resistor

- Why use pull-up resistor?
 - Suppose we have an IC or a Microcontroller Unit (MCU) with an input pin.
 - Say, we have no connection to the IC or (MCU), but the device still reads some value.
 - Do we know whether the input is high or low?
 - It's a phenomenon called floating
 - To prevent this unknown state, we use a pull-up (or pull-down) resistor.

- Points to Note:
 - The value of pull up resistor is really high (order of 10k)
 - Pull-down attach to ground. Pull up attach to voltage.

- When should you use a Pull-up vs. Pull-down?
 - Pull-up: when you want the 'default value' to be 1
 - Pull-down: when you want the 'default value' to be 0

- The value of the pull-up resistor needs to be chosen to satisfy two conditions:
 - *When the button is pressed*, the input pin is pulled low. The value of resistor R1 controls how much current you want to flow from VCC, through the button, and then to ground.
 - *When the button is not pressed*, the input pin is pulled high. The value of the pull-up resistor controls the voltage on the input pin.
- The material for Pull-up resistors was taken from:
 - <https://learn.sparkfun.com/tutorials/pull-up-resistors>

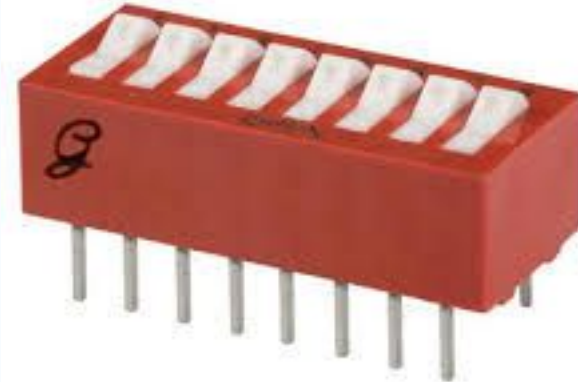
Using ON/OFF buttons for inputs

- Now that you know how to use pull-up/pull-down resistors....you can input a value of 0 or 1 using a “switch” in the form of an ON/OFF button
- The ON/OFF button is equivalent to the switch in the diagrams.
- Question: Can you build a circuit with one button to input a 0 or a 1
 - Connect to the LED circuit you build in Lab1

DIP Switch

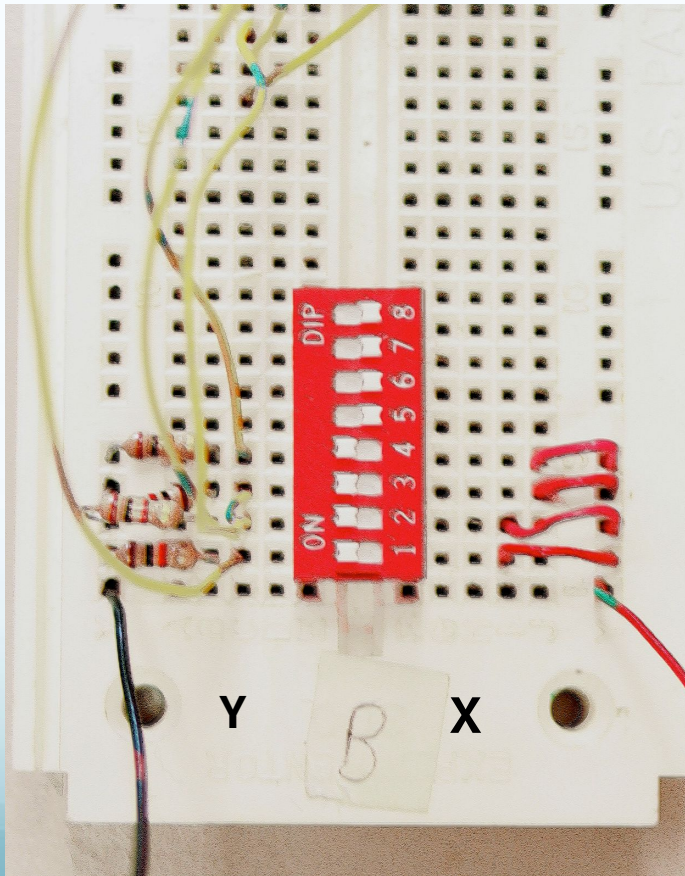
- ▶ set of tiny switches in one package (housing) housing looks like a chip
- ▶ Can set switch to ON or OFF
 - They are toggle switches, i.e., they have two possible positions – on (1) or off (0).
 - Connect one side (inputs) to power bus (Vcc)
 - Connect other side (output) to your circuit
 - If ON then output = 1 (Vcc)
 - OFF then output = 0 (ground)
 - You can also swap things so that ON=0 and OFF=1
- **IMPORTANT: You have to use pull-up (or pull-down) resistors!!**

DIP Switch

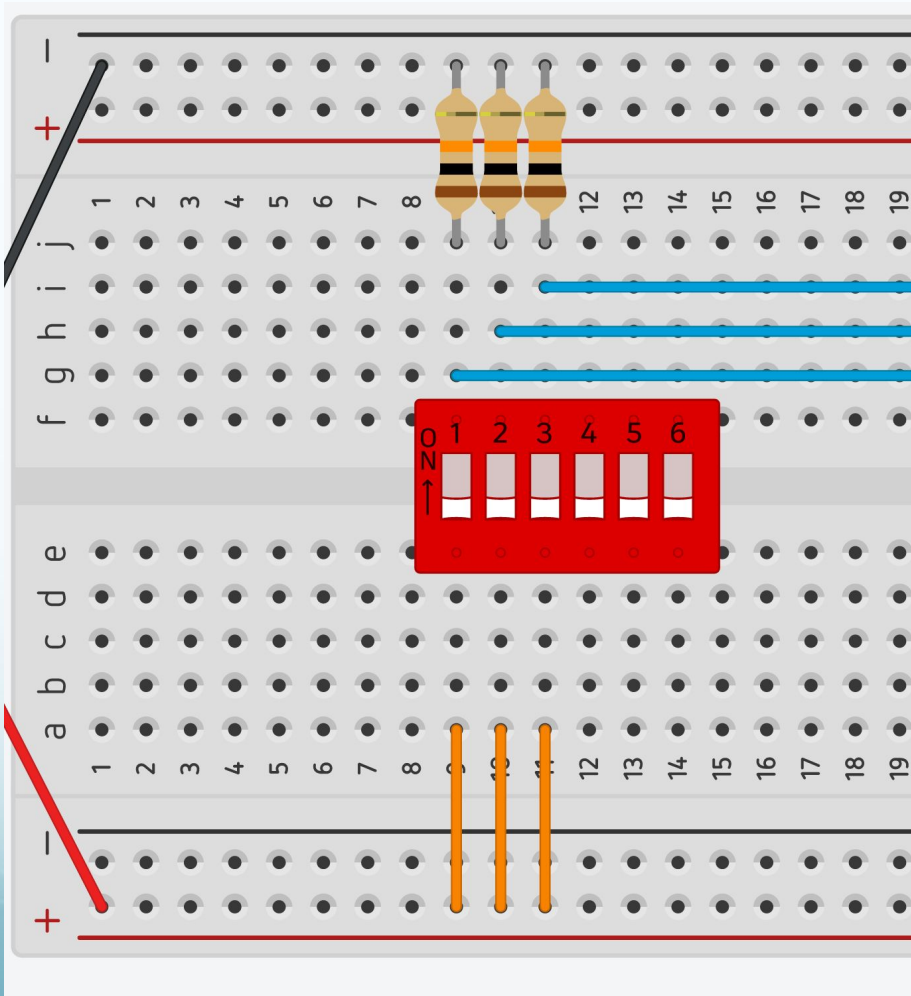


If switch is set to ON then closed circuit – X connects to Y
If switch is set to OFF then no connection

Ex: If X goes to Vcc (1),
then ON means Y=1
OFF means Y=0



DIP Switch in Tinkercad



- ▶ Basic Components→DIP Switch
 - Single DIP Switch
 - 4-bit DIP Switch
 - 6-bit DIP Switch
- ▶ Switch states can only be changed while simulation is running
- ▶ Pull-up/Pull-down still required!
 - **Pay attention to resistance value**

Using DIP switch for your Lab Homework 1

Your homework was to build a circuit (Tinkercad) to compute:

$$S = (A \text{ OR NOT } B) \text{ AND } (B \text{ OR NOT } C)$$

- Modify (i.e., by adding components) your circuit so that the input A,B,C are set by a DIP switch.

Lab Homework 2

- Design and implement a circuit that tests if two 4-bit numbers $A=(A_3 A_2 A_1 A_0)$ and $B=(B_3 B_2 B_1 B_0)$ are equal.
 - Use DIP switches to input your 4-bit number
 - You can use any of the 7400 series integrated circuits
1. First design your logic functions and circuit using basic gates. *Think about the solution on paper first.*
 2. Next identify the 7400 ICs that contain the logic gates you need.
 3. Finally, design your circuit in Tinkercad

See BlackBoard assignment for full specs.